


ФГБОУ ВО «БАШКИРСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ»
ФАКУЛЬТЕТ МАТЕМАТИКИ И ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ

Утверждено:
на заседании кафедры
протокол от « 28 » февраля 20 22 г. № 9
Зав. кафедрой  / С.А. Мустафина

Согласовано:
Председатель УМК факультета
 / А.М. Ефимов

РАБОЧАЯ ПРОГРАММА ДИСЦИПЛИНЫ (МОДУЛЯ)

дисциплина Программирование. Практикум
(наименование дисциплины)

Факультативы

(указать часть (обязательная часть или часть, формируемая участниками образовательных отношений, факультатив))

программа бакалавриата

Направление подготовки (специальность)

Направление 01.03.02 Прикладная математика и информатика
(указывается код и наименование направления подготовки (специальности))

Направленность (профиль) подготовки

"Прикладное программирование и анализ данных"
(указывается наименование направленности (профиля) подготовки)

Квалификация

бакалавр
(указывается квалификация)

Разработчик (составитель)

доцент каф. математического
моделирования, к.ф.-м.н., доцент
(должность, ученая степень, ученое звание)

 / А.М. Ефимов
(подпись, Фамилия И.О.)

Для приема: 2022 г.

Уфа 20 22 г.

BASHKIR STATE UNIVERSITY

FACULTY OF MATHEMATICS AND INFORMATION TECHNOLOGY

Approved:
at the meeting of the department
minutes of " 28 " February 20 22 № 9
department _____ / S. A. Mustafina _____

Agreed:
Chairman of the Faculty
Management Committee
_____ / A. M. Efimov _____

WORKING PROGRAM OF THE DISCIPLINE (MODULE)

discipline Coding Practicum
(name of the discipline)

Electives

(specify part (mandatory part or part formed by participants of educational relations, optional))

программа bachelor's degree program

Training area (specialty)

Direction 01.03.02 Applied mathematics and computer science
(specify the code and name of the training area (specialty))

Focus (profile) of training

"Application Programming and Data Analysis"
(specify the name of the training area (profile))

Qualification

----- bachelor's degree -----
(specify the qualification)

<p>Developer (compiler) <u>Associate Professor of the Department of</u> <u>Mathematical Modeling,</u> <u>PhD, Associate Professor</u> (position, academic degree, academic title)</p>	<p>_____ / <u>A. M. Efimov</u> (signed, Last Name And Full name)</p>
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For admission: 2022

Ufa 20 22

Compiled by: doc. department. matem. modeling A. M. Efimov

The working program of the discipline утверждена was approved at the meeting of the Department of Mathematical modeling protocol of "28" февраля February 20 22, no. 9

Additions and changes made to the work program of the discipline were approved at the meeting of the department _____ ,
protocol no. _____ from " _____ " _____ 20 _ city of _____

Head of the Department _____ / _____ /

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Head of the Department _____ / _____ /

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protocol no. _____ from " _____ " _____ 20 _ city of _____

Head of the Department _____ / _____ /

Additions and changes made to the work program of the discipline were approved at the meeting of the department _____ ,
protocol no. _____ from " _____ " _____ 20 _ city of _____

Head of the Department _____ / _____ /

List of documents and materials

1. List of planned results of training in the discipline, correlated with the indicators of achievement of competencies established in the educational program
2. Purpose and place of the discipline in the structure of the educational program
3. Content of the work program (scope of the discipline, types and types of training sessions, educational and methodological support for independent work of students)
4. Assessment fund for the discipline
 - 4.1. A list of competencies and indicators of achievement of competencies with an indication of the planned results of training in the discipline correlated with them. Description of criteria and scales for evaluating learning outcomes in the discipline.
 - 4.2. Standard control tasks or other materials necessary for evaluating the results of training in the discipline, correlated with the indicators of competence achievement established in the educational program. Methodological materials that define the procedures for evaluating the results of training in the discipline.
5. Educational, methodical and informational support of the discipline
 - 5.1. List of basic and additional educational literature required for mastering the discipline
 - 5.2. List of Internet information and telecommunications network resources and software required for mastering the discipline, including professional databases and information reference systems
6. Material and technical base necessary for the implementation of the educational process in the discipline

1. List of planned results of training in the discipline, correlated with установленными в образовательной программe the indicators of achievement of competencies established in the educational program

Based on the results of mastering the discipline, the student must achieve the following learning outcomes::

Category (group) of competencies (if there is a MIC)	Emerging competence (with code indication)	Code and name of the competence achievement indicator	Results of training in the discipline
<i>Theoretical and practical foundations of professional activity</i>	<i>GPC-2. It is able to use and adapt existing mathematical methods and programming systems for the development and implementation of algorithms for solving applied problems</i>	<i>GPC-2.1. Has fundamental knowledge of existing mathematical methods and programming systems for developing and implementing algorithms for solving applied problems.</i>	<i>Know the existinge mathematicale methodsы andы programming systems for developing and implementing algorithms for solving applied problems.</i>
		<i>GPC-2.2. Is able to use the apparatus of existing mathematical methods and programming systems for the development and implementation of algorithms for solving applied problems in professional activities.</i>	<i>Be able to use the apparatus of existing mathematical methods and programming systems to develop and implement algorithms for solving applied problems in professional activities.</i>
		<i>GPC-2.3. Has skills in applying the apparatus of existing mathematical methods and programming systems to develop and implement algorithms for solving specific problems.</i>	<i>Possess the ability to apply the apparatus of existing mathematical methods and programming systems to develop and implement algorithms for solving specific problems.</i>
	<i>PC-3. Able to use the main conceptual provisions of functional, logical, object-oriented and visual programming directions, methods, methods and tools for program development within these areas</i>	<i>PC-3.1. Knows the main conceptual provisions of functional, logical, object-oriented and visual programming directions, methods, methods and tools for program development within these areas.</i>	<i>Knows the main conceptual provisions of functional, logical, object-oriented and visual programming areas, methods, methods and tools for developing programs in these areas.</i>
		<i>PC-3.2. Can program in functional, logical, object-oriented, and visual programming areas.</i>	<i>Can program in functional, logical, object-oriented, and visual programming areas.</i>
		<i>PC-3.3. Has practical experience in developing programs in functional, logical, object-oriented and visual programming areas.</i>	<i>He has practical experience in developing programs in functional, logical, object-oriented and visual programming areas.</i>

	<i>PC-4. Able to use modern methods of development and implementation of specific algorithms of mathematical models based on programming languages and packages of applied modeling programs</i>	<i>PC-4.1. Knows modern methods of development and implementation of algorithms of mathematical models based on languages and packages of applied modeling programs.</i>	<i>He knows modern methods of developing and implementing algorithms for mathematical models based on languages and packages of applied modeling programs.</i>
		<i>PC-4.2. Can develop and implement algorithms for mathematical models based on modeling languages and application software packages.</i>	<i>Can develop and implement algorithms for mathematical models based on modeling languages and application software packages.</i>
		<i>PC-4.3. Has practical experience in developing and implementing their algorithms based on modeling languages and application software packages.</i>	<i>He has practical experience in developing and implementing their algorithms based on modeling languages and application software packages.</i>

2. Purpose and IFRS of the discipline in the structure of the educational program

Discipline "Coding Practicum" is an optional discipline.

The discipline is studied in the 3rd and 4th year in the 1st and 2nd semesters.

Objectives of studying the discipline: introduction to the capabilities of the Python programming language, its application areas: scientific calculations, machine learning, data analysis and visualization, etc.

To master the discipline, you need competencies formed within the framework of studying the following disciplines: algebra and geometry, mathematical analysis, differential equations, probability theory and mathematical statistics, programming languages and methods.

3. Content of the work program (scope of the discipline, types and types of training sessions, educational and methodological support for independent work of students)

The content of the work program is presented in Appendix No. 1.

4. Assessment fund for the discipline

4.1. A list of competencies and indicators of achievement of competencies with an indication of the planned results of training in the discipline correlated with them. Description of criteria and scales for evaluating learning outcomes in the discipline.

Code and wording of the competence: GPC-2. It is able to use and adapt existing mathematical methods and programming systems for developing and implementing algorithms for solving applied problems.

Code and name индикатора достижения of the competence achievement indicator	Results of training in the discipline	Criteria for evaluating learning outcomes	
		"Notcountedo"	"Credited"
<i>GPC-2.1. Has fundamental knowledge of existing mathematical methods and programming systems for developing and implementing algorithms for solving applied problems.</i>	<i>Know the existinge mathematicale methodsы andы programming systems for developing and implementing algorithms for solving applied problems.</i>	Fragmentary representations of existing mathematical methods and programming systems for developing and implementing algorithms for solving applied problems.	Formed, but possibly containing some gaps, ideas about existing mathematical methods and programming systems for developing and implementing algorithms for solving applied problems.
<i>GPC-2.2. Is able to use the apparatus of existing mathematical methods and programming systems for the development and implementation of algorithms for solving applied problems in professional activities.</i>	<i>Be able to use the apparatus of existing mathematical methods and programming systems to develop and implement algorithms for solving applied problems in professional activities.</i>	Fragmentary skills to use the apparatus of existing mathematical methods and programming systems for the development and implementation of algorithms for solving applied problems in professional activities.	Generally successful, systematic, but possibly containing some gaps, ability to use the apparatus of existing mathematical methods and programming systems for the development and implementation of algorithms for solving applied problems in professional activities.
<i>GPC-2.3. Has skills in applying the apparatus of existing mathematical methods and programming systems to develop and implement algorithms for solving specific problems.</i>	<i>Possess the ability to apply the apparatus of existing mathematical methods and programming systems to develop and implement algorithms for solving specific problems.</i>	Fragmentary knowledge of the ability to apply the apparatus of existing mathematical methods and programming systems for the development and implementation of algorithms for solving specific problems.	Generally successful, systematic, but possibly containing some gaps in the application of the abilityto applications of the apparatus of existing mathematical methods and programming systems for the development and implementation of algorithms for solving specific problems.

Code and wording of the competence: PC-3. It is able to use the main conceptual provisions of functional, logical, object-oriented and visual programming areas, methods, methods and tools for developing programs within these areas.

Code and name индикатора достижения of the competence achievement indicator	Results of training in the discipline	Criteria for evaluating learning outcomes	
		"Notcountedo"	"Credited"
<i>PC-3.1. Knows the main conceptual provisions of functional, logical, object-oriented and visual programming areas, methods, methods and tools for developing programs within these areas.</i>	<i>Knows the main conceptual provisions of functional, logical, object-oriented and visual programming areas, methods, methods and tools for developing programs in these areas.</i>	Fragmentary ideas about the main conceptual provisions of functional, logical, object-oriented and visual programming areas, methods, methods and tools for developing programs within these areas.	Formed, but possibly containing some gaps, ideas about the main conceptual provisions of functional, logical, object-oriented and visual programming areas, methods, methods and tools for developing programs within these areas.
<i>PC-3.2. Can program in functional, logical, object-oriented, and visual programming areas.</i>	<i>Can program in functional, logical, object-oriented, and visual programming areas.</i>	Fragmented programming skills in functional, logical, object-oriented, and visual programming areas.	Generally successful, systematic, but possibly containing some gaps <i>сумение</i> , programming skills within the functional, logical, object-oriented, and visual programming areas.
<i>PC-3.3. Has practical experience in developing programs in functional, logical, object-oriented and visual programming areas.</i>	<i>He has practical experience in developing programs in functional, logical, object-oriented and visual programming areas.</i>	Fragmentary knowledge of the ability to develop programs within the framework of functional, logical, object-oriented and visual programming areas.	Generally successful, systematic, but possibly containing some gaps in the application of abilities and program development in the framework of functional, logical, object-oriented and visual programming areas.

Code and wording of the competence: PC-4. It is able to use modern methods of developing and implementing specific algorithms for mathematical models based on programming languages and modeling application software packages.

Code and name индикатора достижения of the competence achievement indicator	Results of training in the discipline	Criteria for evaluating learning outcomes	
		"Notcountedo"	"Credited"
<i>PC-4.1. Knows modern methods of developing and implementing algorithms for mathematical models based on languages and packages of applied modeling programs.</i>	<i>He knows modern methods of developing and implementing algorithms for mathematical models based on languages and packages of applied modeling programs.</i>	Fragmentary views on modern methods of developing and implementing mathematical model algorithms based on modeling languages and application software packages.	Formed, but possibly containing some gaps, ideas about modern methods of developing and implementing algorithms for mathematical models based on languages and packages of applied modeling programs.
<i>PC-4.2. Can develop and implement algorithms for mathematical models based on modeling languages and application software packages.</i>	<i>Can develop and implement algorithms for mathematical models based on modeling languages and application software packages.</i>	Fragmentary skills to develop and implement mathematical model algorithms based on modeling languages and application software packages.	Generally successful, systematic, but possibly containing some gaps, ability to develop and implement algorithms for mathematical models based on modeling languages and application software packages.
<i>PC-4.3. Has practical experience in developing and implementing their algorithms based on modeling languages and application software packages.</i>	<i>He has practical experience in developing and implementing their algorithms based on modeling languages and application software packages.</i>	Fragmentary knowledge of the ability to develop and implement their algorithms based on modeling languages and application software packages.	Generally successful, systematic, but possibly containing some gaps, application of the ability to develop and implement their algorithms based on modeling languages and application software packages.

4.2. Standard control tasks or other materials necessary for evaluating the results of training in the discipline, correlated with the indicators of competence achievement established in the educational program. Methodological materials that define the procedures for evaluating the results of training in the discipline.

Code and name of the competence achievement indicator	Results of training in the discipline	Evaluation tools
<i>GPC-2.1. Has fundamental knowledge of existing mathematical methods and programming systems for developing and implementing algorithms for solving applied problems.</i>	<i>Know the existing mathematical methods and programming systems for developing and implementing algorithms for solving applied problems.</i>	Individual, group survey; control work, interview
<i>PC-3.1. Knows the main conceptual provisions of functional, logical, object-oriented and visual programming areas, methods, methods and tools for developing programs within these areas.</i>	<i>Knows the main conceptual provisions of functional, logical, object-oriented and visual programming areas, methods, methods and tools for developing programs in these areas.</i>	
<i>PC-4.1. Knows modern methods of developing and implementing algorithms for mathematical models based on languages and packages of applied modeling programs.</i>	<i>He knows modern methods of developing and implementing algorithms for mathematical models based on languages and packages of applied modeling programs.</i>	
<i>GPC-2.2. Is able to use the apparatus of existing mathematical methods and programming systems for the development and implementation of algorithms for solving applied problems in professional activities.</i>	<i>Be able to use the apparatus of existing mathematical methods and programming systems to develop and implement algorithms for solving applied problems in professional activities.</i>	Individual or group survey; laboratory work;
<i>PC-3 interview.2. Can program in functional, logical, object-oriented, and visual programming areas.</i>	<i>Can program in functional, logical, object-oriented, and visual programming areas.</i>	
<i>PC-4.2. Can develop and implement algorithms for mathematical models based on modeling languages and application software packages.</i>	<i>Can develop and implement algorithms for mathematical models based on modeling languages and application software packages.</i>	
<i>GPC-2.3. Has skills in applying the apparatus of existing mathematical methods and programming systems to develop and implement algorithms for solving specific problems.</i>	<i>Possess the ability to apply the apparatus of existing mathematical methods and programming systems to develop and implement algorithms for solving specific problems.</i>	II Practical task, RGR; exam
<i>PC-3 exam.3. Has practical experience in developing programs in functional, logical, object-oriented and visual programming areas.</i>	<i>He has practical experience in developing programs in functional, logical, object-oriented and visual programming areas.</i>	
<i>PC-4.3. Has practical experience in developing and implementing their algorithms based on modeling languages and application software packages.</i>	<i>He has practical experience in developing and implementing their algorithms based on modeling languages and application software packages.</i>	

The evaluation criteria for the *module-rating system* are the points that are awarded by the teacher for the types of activities (evaluation tools) based on the results of studying the modules (sections of the discipline) listed in the discipline rating plan (*for the exam*: current control-a maximum of 40 points; boundary control-a maximum of 30 points, incentive points – a maximum of 10; *for offsets*: current control – a maximum of 50 points; border control-a maximum of 50 points, incentive points – a maximum of 10).

Rating scales:

(for the exam:

from 45 to 59 points – "satisfactory".

from 60 to 79 points – "good".

from 80 points – "excellent".

for credit purposes:

credited – from 60 to 110 rating points (including 10 incentive points),

not credited – from 0 to 59 rating points).

Rating-discipline plan

Programming. Workshop

(name of the discipline according to the working curriculum)

course of study _____ 01.03.02 Applied mathematics and Computer Science

course 3, semester 1(5)

Types of academic activities of students	Score for a specific task	Number of tasks per semester	Points	
			Minimum	Max.
Module 1.				
Язык программирования The Python programming language. Language syntax, built-in data types. A conditional statement in Python.			0	40
Current monitoring				
1. Classroom work (individual, group survey, interview)	5	4		20
2. Test control				
Border control				
1. Test lab work	10	2		20
Module 2.				
Loops in Python. Lists, tuples, and dictionaries. Functions in Python. NumPy Library.			0	60
Current monitoring				
1. Classroom work (individual, group survey, interview)	5	6		30
2. Test control				
Border control				
1. Test lab work	10	3		30
Reward points				
1. Student Olympiad or essay contest	10	1	0	10

2. Publishing articles				
3. Working with students (clubs, contests, and Olympiads)				
Attendance (points are deducted from the total amount of points scored)				
1. Attending lectures			0-6	-6
2. Attending practical (seminar, laboratory)classes			0	-10
Final control				
1. Offset (differentiated offset)				
2. Exam				

Rating-discipline plan

Programming. Workshop

(name of the discipline according to the working curriculum)

course of study _____ 01.03.02 Applied mathematics and Computer Science

course 3, semester 2(6)

Types of academic activities of students	Score for a specific task	Number of tasks per semester	Points	
			Minimum	Max.
Module 1.				
Working with files in Python. Библиотека SymPy library. Differentiation, integration, and calculation of limits. Solving ordinary differential equations.			0	40
Current monitoring				
1. Classroom work (individual, group survey, interview)	5	4		20
2. Test control				
Border control				
1. Test lab work	10	2		20
Module 2.				
Scientific graphics in Python. The matplotlib library. Pyplot. Basic graphical commands. Plotting functions in different coordinate systems. Библиотека The SciPy.integrate library. Numerical integration. Numerical solution of the ODE.			0	60
Current monitoring				
1. Classroom work (individual, group survey, interview)	5	6		30
2. Test control				
Border control				
1. Test lab work	10	3		30
Reward points				
1. Student Olympiad or essay contest	10	1	0	10

2. Publishing articles				
3. Working with students (clubs, contests, and Olympiads)				
Attendance (points are deducted from the total amount of points scored)				
3. Attending lectures			0-6	-6
4. Attending practical (seminar, laboratory)classes			0	-10
Final control				
1. Offset (differentiated offset)				
2. Exam				

Rating-discipline plan

Programming. Workshop

(name of the discipline according to the working curriculum)

course of study _____ 01.03.02 Applied mathematics and Computer Science _____

course 4 , semester 1(7)

Types of academic activities of students	Score for a specific task	Number of tasks per semester	Points	
			Minimum	Max.
Module 1.				
Библиотеки pandas, pandas and SciPy. stats libraries. Descriptive statistics.			0	40
Библиотеки pandas, The pandas and SciPy.stats libraries. Testing a hypothesis about the type of distribution.				
Current monitoring				
1. Classroom work (individual, group survey, interview)	5	4		20
2. Test control				
Border control				
1. Test lab work	10	2		20
Module 2.				
Библиотеки pandas, pandas and SciPy. stats libraries. Analysis of variance.			0	60
Библиотеки pandas, The pandas and SciPy.stats libraries. Correlation analysis.				
Библиотеки pandas, The pandas and SciPy.stats libraries. Regression analysis.				
Current monitoring				
1. Classroom work (individual, group survey, interview)	5	6		30
2. Test control				
Border control				
1. Test lab work	10	3		30

Reward points				
1. Student Olympiad or essay contest	10	1	0	10
2. Publishing articles				
3. Working with students (clubs, contests, and Olympiads)				
Attendance (points are deducted from the total amount of points scored)				
5. Attending lectures			0-6	-6
6. Attending practical (seminar, laboratory)classes			0	-10
Final control				
1. Offset (differentiated offset)				
2. Exam				

Rating-discipline plan

Programming. Workshop

(name of the discipline according to the working curriculum)

course of study _____ 01.03.02 Applied mathematics and Computer Science

course 4, semester 2(8)

Types of academic activities of students	Score for a specific task	Number of tasks per semester	Points	
			Minimum	Max.
Module 1.				
Neural networks. Programming an artificial neuron. Neural networks. Keras, TensorFlow, or Theano libraries. Programming an artificial neuron..			0	40
Current monitoring				
1. Classroom work (individual, group survey, interview)	5	4		20
2. Test control				
Border control				
1. Test lab work	10	2		20
Module 2.				
Neural networks. Programming an artificial neural network. Neural networks. Keras, TensorFlow, or Theano libraries. Programming an artificial neural network.			0	60
Current monitoring				
1. Classroom work (individual, group survey, interview)	5	6		30
2. Test control				
Border control				
1. Test lab work	10	3		30
Reward points				

1. Student Olympiad or essay contest	10	1	0	10
2. Publishing articles				
3. Working with students (clubs, contests, and Olympiads)				
Attendance (points are deducted from the total amount of points scored)				
7. Attending lectures			0-6	-6
8. Attending practical (seminar, laboratory)classes			0	-10
Final control				
1. Offset (differentiated offset)				
2. Exam				

Sample list of questions for an individual or group survey or interview

Язык программирования *The Python programming language*

What XML fragment will be generated as a result of executing the following code:

```
from xml.dom import minidom
e1 = minidom.Element("A")
e2 = minidom.Element("B")
e3 = minidom.Element("C")
e1.appendChild(e2)
e1.appendChild(e3)
print e1.toxml()
```

- <A><C><C/>
 - <A><C/>
 - <A><C>
 - <A><C/>
-

What is the name of the relation that the following two classes have:

```
class A(object):
    def __init__(self, x):
        self._mydata = x
    def m1(self):
        raise NotImplementedError
```

```
class B(A):
    def __init__(self, x):
        super(B, self).__init__(x)
    def m1(self):
        return self._mydata
```

- aggregation. Instances of A contain instances of class B
 - inheritance. B is obtained by inheriting the A
 - association. Instances of A contain references to instances of class B
 - inheritance. A is obtained by inheriting B
-

How is the Main Heading string used in the following example?

```
<h1 tal:content="here/title">Main Heading</h1>
```

- the string is not used
 - as a stub, so that visual formatting tools can show that the formatted
 - string contains a value that can be referenced elsewhere in the document
 - as a variable name for macro substitution
-

What does the normalize() method of a DOM object do?

- prepares XML for beautiful output
 - corrects XML by adding missing tags
 - removes spaces around text
 - brings together all consecutive text nodes
-

What does the following program do?


```

import threading
l = threading.RLock()

def proc(nm, n=0):
    l.acquire()
    try:
        if n < 5:
            print "*",
            return proc(nm, n+1)
        else:
            return nm
    finally:
        l.release()

for i in range(5):
    threading.Thread(target=proc, args=(str(i),)).start()

```

- prints 5 asterisks
 - crashes when trying to execute l.acquire() a second time
 - prints 25 asterisks
 - prints 1 asterisk and freezes
 - continuously prints asterisks
-

There is a class definition:

```

class Ex:
    def __init__(self, x, y):
        xy = x, y
        self.position = xy
        self._length = self.__len(x, y)
    def __len(self, x, y):
        return abs(x) + abs(y)
    def getlen(self):
        return self._length
p = Ex(1, 2)

```

Which of the options for using it is not allowed in Python programs that use instances of the Ex class?

- print p.getlen()
 - print p.__len(1,2)
 - print p.position
-

Given an array:

```
>>> c = array([[1,2], [2,3], [4,5]])
```

What is the c[:,1] slice equal to?

- array([1, 2, 4])
 - array([2, 3, 5])
 - array([1, 2])
 - array([2, 3])
-

The class has __iter__() methods and next(). What does this mean and how to use this method?

```
class A:
```

```
#...
def __iter__(self):
    #...
def next(self):
    #...
a = A(1, 2, 3)
```

- iterator. You can use it like this: for i in a: print i
 - there is no special name. You can use it like this: print a.next()
 - generator. You can use it like this: for i in a(): print i
 - sequence. You can use it like this: print a[2]
-

What new names will appear in the current module after executing the following code:

```
import sre as re
from re import compile
```

- you can't do import and from at the same time-import
- only sre and compile names
- only the names re and compile
- names only sre, re and compile names

What will the execution result be equal to?

```
urlparse.urlsplit("http://google.com/search?q=Python#1")?
```

- ('http', 'google.com', '/search', 'q=Python', '1')
- ('http', 'google.com', '/search', '', 'q=Python', '1')
- ('http', 'google.com', 'search', 'q=Python', '1')
- ('http://', 'google.com/', 'search?', 'q=Python#', '1')

The beginning of the function definition f looks like this:

```
def f(a, b, c=1, *p, **k):
```

Which of the following call options will not cause an error at the stage of assigning actual parameters to formal ones?

- f(1, 2, 3, 4)
 - f()
 - f(1, 2, d=3, c=4)
 - f(1, d=2, 3)
 - f(1, 2)
 - f(1, 2, d=3)
-

Для чего применяется метод What is the nextset() method used for? the cursor object?

- to get the next set of query result records
 - to get the next query result record
 - to go to the next query result record
 - to go to the next set of query result records
-

What code generates the following button layout?

```
# 1
b1.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=SE)
b2.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=NE)
b3.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=SW)
b4.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=NW)

# 2
b1.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=SE)
b2.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=NE)
b3.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=SW)
b4.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=NW)

# 3
b1.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=NW)
b2.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=SW)
b3.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=NE)
b4.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=SE)

# 4
b1.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=NW)
b2.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=SW)
b3.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=NE)
b4.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=SE)
```

- 1
 - 3
 - 4
 - 2
-

In which module should I look for functions that help test the program?

- dictutils
 - unittest
 - profile
 - pdb
-

How poplib is a POP3 server session represented in the poplib module?

- list of tuples
 - a set of functions
 - instance
 - of the POPZ tuple class
-

What values will the groups get in the following example?

```
>>> m = re.match("(?P<a>A*?) (?:B+) (?P<b>B+?) (?P<c>C??)", "AAAABBBBC")
>>> m.groupdict()
```

- {'a': 'AAAA', 'c': 'C', 'b': 'B'}
- {'a': 'AAAA', 'b': 'BBBB'}
- {'a': 'AAAA', 'c': '», 'b': 'B'}
- {'a': 'AAAA', 'b': 'B'}

Which of the mod_python handlers listed is executed before the others?

- PythonPostReadRequestHandler
 - PythonFixupHandler
 - PythonAuthenHandler
 - PythonHandler
-

What will be obtained as a result of evaluating the following expression:

```
(0 < 5 <= 3) and (0 / 0)
```

- будет возбуждено исключение a ZeroDivisionError (division by zero)exception will be raised
 - syntax error
 - False (or 0)
 - True (or 1)
-

What will be output as a result of performing a regular expression match?

```
>>> m = re.match("(a*?) (a+) (b+?) ", "aaabbb")
>>> print m.groups()
```

- (», 'aaa', 'b')
 - ('aa', 'a', 'b')
 - ('aa', 'a', 'bbb')
 - ('a', 'aa', 'b')
-

Which of the following regular expressions is incorrect?

- [a]*?
 - a+b++
 - (a+b+)+
 - (?P<k>(ac))
-

Why use namespaces in XML?

- namespaces allow you to include XML documents of the same type in each other
 - to combine XML with different DTDs in a single document
 - , namespaces allow you to specify options for an application that processes XML
 - to mark tags for easier search
-

The following program replaces one substring with another in the text on the left, writing the text in the widget on the right. What mistakes were made in it допущены?

```
from Tkinter import *
from ScrolledText import ScrolledText

def transl():
    txt = t1.get("1.0", END).replace(e1.get(), e2.get())
    t2.delete()
    t2.insert(END, txt)

tk = Tk()
```

```
f = Frame(tk)
e1 = Entry(f, background="White", width=32)
e1.pack(side=LEFT)
b = Button(f, text=">>", command=transl)
b.pack(side=LEFT)
e2 = Entry(f, background="White", width=32)
e2.pack(side=LEFT)
f.grid(row=0, column=0, columnspan=2)
t1 = ScrolledText(tk, background="White", width=40)
t1.grid(row=1, column=0)
t2 = ScrolledText(tk, background="White", width=40)
t2.grid(row=1, column=1)
tk.mainloop()
```

widget f should take up three cells, not two (it has a button and two input bars)

no errors

✓ метод the deletethe delete text method does not contain the positions

функция of the text being deleted the transl () function must have an argument

What is a regular expression?

template for formatting operation

✓ template describing multiple lines

template for searching files in a directory

syntactically correct expression in Python

What code generates the following button layout?

b1.pack(side=BOTTOM); b2.pack(side=BOTTOM)

b1.pack(side=TOP); b2.pack(side=BOTTOM)

✓ b2.pack(side=BOTTOM); b1.pack(side=BOTTOM)

b1.pack(side=BOTTOM); b2.pack(side=TOP)

What are the functions of the gettext module for?

to display a line of input on the screen and input text from the user

to receive text from the user

to read a line from standard input

✓ to ensure internationalization of the program

Which function is analogous to the function x?

```
def x(a, b):
    for c in b:
        yield a(*c)
```

itertools.izip()

✓ itertools.starmap()

itertools.imap()

map(None, ...)

What is the namespaceURI attribute in the <foaf:nick> element from the following XML fragment?

```
<rdf:RDF xmlns:foaf="http://xmlns.com/foaf/0.1/">
...
<foaf:nick>donna</foaf:nick>
```

- foaf
- rdf:RDF
- nick
- http://xmlns.com/foaf/0.1/

What programming paradigms and styles does Python support?

- logistics Programming
 - Imperative programming
 - Structural style
 - Modular programming
-

Can deadlock occur in the following program?:

```
import threading

res_A = threading.Lock()
res_B = threading.Lock()
res_C = threading.Lock()

def proc1():
    res_A.acquire(); res_B.acquire(); res_C.acquire()
    # ...
    res_B.release(); res_C.release(); res_A.release()

def proc2():
    res_B.acquire(); res_C.acquire(); res_A.acquire()
    # ...
    res_C.release(); res_B.release(); res_A.release()

def proc3():
    res_C.acquire(); res_A.acquire(); res_B.acquire()
    # ...
    res_A.release(); res_B.release(); res_C.release()

p1 = threading.Thread(target=proc1, name="t1")
p2 = threading.Thread(target=proc2, name="t2")
p3 = threading.Thread(target=proc3, name="t3")
p1.start(); p2.start(); p3.start()
p1.join(); p2.join(); p3.join();
```

- yes, possible
 - no, no
 - yes, required
-

What value of threadsafety corresponds to a situation where threads can simultaneously use both a DB-API 2.0 compatible module and connections obtained based on this module

- 3
- 1
- 0

✓ 2

Can I use custom tags in XML?

- you can if they are specified by the DTD
 - ✓ you can
 - not
 - you can if namespaces are specified
-

In what order will Zope search for index_html for the next URL?

http://zopeserver/Zigzag/Example/index_html

- in the /Zigzag/Example and /Zigzag directories
 - ✓ in the /Zigzag/Example, /Zigzag and /directories????
 - only in the /Zigzag/Example / directory
 - in in the /, /Zigzag, and /Zigzag/Example directories
-

Which class instances combine a lock and a means of communication between threads?

- ✓ Condition
 - Event
 - Timer
 - Lock
-

How can I use Python itself to determine the names of formal arguments to the func ()function, if it is known that the function is written in Python?

- func.func_locals
 - никак
 - func.func_globals
 - ✓ inspect.getargspec(func)
-

What source code encodings does the Python interpreter support?

- ✓ most encodings used today
 - are ASCII
 - ASCII, Latin-1, UTF-8
 - ASCII, Unicode
-

What role does xx play in a Python program, and what should XXX be equal to:

```
class A(object):
    def xx():
        return A.__name__
xx = XXX(xx)
```

- method, XXX equals instancemethod
- class method, XXX equals classmethod
- function, XXX can

be omitted as a static method, XXX equals staticmethod

What method lets you find out if a given message has multiple parts?

- ✓ is_multipart()
 - ✓ get_main_type()
 - get_payload()
 - items()
-

What will be output as a result of executing the following code:

```
from xml.sax.saxutils import XMLGenerator
g = XMLGenerator(encoding="utf-8")
g.startDocument()
g.startElement("A", {})
g.startElement("B", {'b': '1'})
g.endElement("B")
g.startElement("B", {'b': '2'})
g.endElement("B")
g.endElement("A")
g.endDocument()
```

<?xml version="1.0" encoding="utf-8"?><A><B b=1><B b=2>

<?xml version="1.0" encoding="utf-8"?><A><B b="1"><B b="2">

<?xml version="1.0" encoding="utf-8"?><A><B b="1" b="2">

✓ <?xml version="1.0" encoding="utf-8"?><A><B b="1"><B b="2">

What mistakes were made in the following example?

```
import threading, Queue

item = Queue.Queue()

def consumer(nm):
    for i in range(3):
        print item.get(), nm

def producer(nm):
    for i in range(4):
        item.put(nm)

for n in range(4):
    threading.Thread(target=consumer, args=("c"+str(n),)).start()
for n in range(3):
    threading.Thread(target=producer, args=("p"+str(n),)).start()
```

the object corresponding to the thread must be given a separate name

threads-queue consumers are started before producer threads

the program will hang, since there are fewer producers than consumers

✓ ,there are no errors

What string will be obtained as a result of the following operation:


```
"=%1s %2.2f %03i=" % ("abc", 1.234, 4)
```

=a 01.23 004=

=c 1.23 004=

=a 1.23 004=

=abc 1.23 004=

What will be output by the next program:

```
a = "AB"  
b = "BC"  
print "%sa, b" % a, b
```

('AB', 'BC')a, b

«AB», «BC»a, b

(AB, BC)a, b

ABa, b BC

What string will be obtained as a result of the following operation:

```
"=%-3s %1.0f %-3i=" % ("a", 1.234, 4)
```

=a 1 4=

= a 1 4=

=a 1 4 =

What does Zope include?

General-purpose DBMS

CGI scripting support

DTML scripting support

Native web server

How do I convert the Unicode string u to koi8-encoding?

string.decode(u, 'koi8-r')

u.encode('koi8-r')

u.recode('unicode', 'koi8-r')

u.decode('koi8-r')

What level of the open system interaction model does the FTP protocol belong to?

to

the network and session transport layer of applications

session key

to a transport company

applications

Which of the listed functions have side effects:

```

import os
global v
v = 0

def A(x, y):
    return abs(x + y)

B = lambda k, v: os.environ.setdefault(k, v)

def C(x):
    global v
    v = v + 1
    return v + x

```

- none of them
- no changes only B and C only C A, B, C only A and C
- C only
- A, B, C
- only A and C

What are the correct statements about the following fragment of a program that works with a POP3 server?

```

import poplib, email

p = poplib.POP3('pop3.SERVER')
p.getwelcome()
p.user('USERNAME')
p.pass_('USERPASSWORD')
lst = p.list()
#
# lst processing
#
p.quit()

```

- there are no errors it is not necessary to do quit (), it will execute itself
- метод the list() method has a different result format: the server response, a list of strings, and the length of the response. It would be correct to write: response, lst, octets = p. list()
- user credentials (login and password) are passed immediately in the user method, and not in a separate pass_()method

What does the following program do?

```

import threading, Queue

item = Queue.Queue()

def consumer(nm):
    while True:
        print item.get(), nm

def producer(nm):
    while True:
        item.put(nm)

for n in range(3):
    threading.Thread(target=consumer, args=("c"+str(n),)).start()
    threading.Thread(target=producer, args=("p"+str(n),)).start()

```

- the program continuously prints strings of the form pN cM, where N is the manufacturer's number and M is the consumer's number
- the program contains an error in the loop where threads are started

the program continuously prints strings of the form p0 c0, p1 c1 or p2 c2, where the number after p is the manufacturer's number and the number after c is the consumer's number

the program does nothing it doesn't do this, or, in some cases, it manages to print several lines of the pN cMformat, after which it stops trying to read from an empty queue

Which built-in Python function is best suited for chained calculations (in particular, calculating the value of a polynomial using the Horner scheme)?

- reduce()
 - map()
 - chain()
 - filter()
-

Which module of the Python standard library allows you to work with WWW at a lower level?

- httplib
 - urlparse
 - htmllib
 - urllib2
-

What paramstyle value paramstyle does the following markup example correspond to?:

```
" " " INSERT INTO tv (tvdate, tvweekday, tvchannel)
VALUES (%s, %s, %s);" " "
```

- 'format'
 - 'pyformat'
 - 'named'
 - 'qmark'
-

What code generates the following button layout?

```
# 1
b1.grid(row=0, column=0, rowspan=2)
b2.grid(row=0, column=1)
b3.grid(row=1, column=1)

# 2
b1.grid(row=0, column=0, columnspan=2)
b2.grid(row=1, column=0)
b3.grid(row=1, column=1)

# 3
b1.grid(row=1, column=1, rowspan=2)
b2.grid(row=1, column=0)
b3.grid(row=0, column=0)

# 4
b1.grid(row=1, column=1, columnspan=2)
b2.grid(row=0, column=1)
b3.grid(row=0, column=0)
```

- 2
- 1

3

4

What are the correct statements about the following fragment of a program that works with a POP3 server?

```
import poplib, email

p = poplib.POP3('pop3.SERVER')
p.getwelcome()
p.user('USERNAME')
p.pass_('USERPASSWORD')
response, lst, octets = p.list()
#
# lst processing
#
p.quit()
```

you don't need to do quit(). it will be executed by itself

.user credentials (username and password) are passed immediately in the user method, and not in a separate pass_()method

no errors

метод the list() method has a different result format: just a list. Errors (response) are transmitted by raising exceptions, if necessary

Hiding information about the internal structure of an object, in which all work with the object is carried out only through the public interface is called

aggregation

abstraction

decomposition

and encapsulation

Which of the following methods can be used to get a random element of the lst sequence using the random module?

random.random(lst)

random.choice(lst)

random.shuffle(lst); lst[0]

lst[random.randrange(len(lst))]

How can I get a list of currently active threads?

threading.enumerate()

threading.currentThread()

threading.active()

threading.activeCount()

How do I start interactive debugging of a function f with two arguments (conditionally: x and y)?

import pdb; pdb.runcall(f(x, y))

import pdb; pdb.runcall(f, (x, y))

import pdb; pdb.runcall("f(x, y)")

```
✓ import pdb; pdb.runcall(f, x, y)
```

What string will be obtained as a result of the following operation:

```
"=%r %0.1f %03i=" % ("abc", 1.234, 3)
```

=abc 1.2 3=

✓ ='abc' 1.2 003=

= 'abc' .2 3=

= 'abc' 1.2 3 =

Which macro is the most convenient way to define a documentation line when using the C API?

✓ PyDoc_STRVAR

PyDoc

PyDoc_VAR

PyDoc_STR

What will be output by the next program:

```
a = "A"  
b = "B"  
b = b + a  
print a + b
```

✓ ABA

error message in the third line

va

AB

Which of the mod_python handlers listed is executed before the others?

PythonHeaderParserHandler

✓ PythonPostReadRequestHandler

PythonAuthenHandler

PythonHandler

What is the name of the relation that the following two classes have between them?:

```
class A(object):  
    def __init__(self, **atts):  
        self._atts = atts  
    def __repr__(self):  
        return ":" + str(self._atts)
```

```
class B(list):  
    def __init__(self, *params):  
        super(B, self).__init__(params)
```

✓ classes are not linked by

association. Instances of A contain references to instances of B

aggregation. Instances of B contain instances of the A

association. Instances of B contain references to instances of A

In what parts of the program are errors made in the following example?

```
import threading

# 1
def proc(*args):
    print "The process in the stream has started!"
    while 1:
        pass

# 2
p1 = threading.Thread(target=proc(), name="t1", args=[2])

# 3
p1.start()
```

- no errors
 - 2
 - 3
 - 1
-

Which class from which module of the email package can be used to attach a binary file to a message?

- MimeMultipart module MIMEMultipart, класс, MimeMultipart class
 - MimeMessage module MIMEMessage, класс, MimeMessage class
 - MIMEBase module MIMEBase, MIMEBase class Utils
 - moduleUtils module, MIME class
-

In which environment variable is the user name passed (if authorization is applied)?

- REMOTE_USER
 - LOGIN
 - USER_NAME
 - USER
-

In which of the following cases is it more convenient to embed the Python interpreter in the software system?

- when the system requires functionality that is more convenient for the user to describe in a script language, but the system is originally written in C / C++
 - the system is available as a binary library
 - when the system allows you to call external scripts
 - the system is delivered as an application package
-

How many elements will the dictionary D contain (i.e., what will len(D) be equal to) after executing the following code:

```
D = {}
D[1], D[2], D[3] = "ABB"
D[0], D[1] = "AB"
```

- 4
- 2

3

3 and an error occurs in the 3rd line

How does the `mod_python` handler transmit the response to the request?

- by using a special object representing a request passed as a parameter
 - by assigning values to environment variables
 - using a function call
 - , similar to a CGI script
-

How many public methods will an instance of class ABC have, and what will the `a ()` method call return?

```
class A(object):
    def a(self): return 'a'
class B(object):
    def b(self): return 'b'
class C(object):
    def c(self): return 'c'

class AB(A, B):
    def a(self): return 'ab'
class BC(B, C):
    def a(self): return 'bc'
class ABC(AB, B, C):
    def a(self): return 'abc'
```

3, will return a

3, will return ab

5, a

will return ab 3, will return abc

What template can be used for an event where the F5 key is pressed while the Shift key is pressed?

- `<Shift-F5>`
 - `<ButtonPress-Shift-F5>`
 - `<F15>`
 - `<Shift_L-F5>` и `<Shift_R-F5>`
-

What directories does Python search for modules in?

- in the directories specified in the `PATH` environment variable
 - in the current directory
 - in the directories specified in the `sys.path` list
 - in the directory where standard modules are installed
-

What does the `time.strftime ()` function do?

- formats the date and time value according to the specified format
- formats the date and time value according to the ISO standard
- format reads the date and time from the string according to the specified format
- converts the string to a real time value

How many memory consuming lists are involved in the following program:

```
for i in itertools.izip(xrange(10**6), xrange(10**6)):  
    pass  
 1  
 3  
 0  
 2
```

What use cases for the values of the gg generator expression make sense?

```
gg = ((s[i], s[i+1]) for i in range(0, len(s)-1, 2))  
 print len(gg)  
 print list(gg)  
 d = dict(gg)  
 print gg
```

Currying is...

- passing a function to another function
 - transferring function parameters to its result
 - returning a function object from another function
 - getting a new function based on the specified function, in which part of the arguments gets a value
-

How do I define a function in Python?

- using the def statement
 - to set a list of source code strings
 - using a lambda expression
 - using the import statement
-

Given an array:

```
>>>c = array([[1,2], [2,3], [4,5]])
```

What is the slice c[1] equal to?

- array([1, 2])
 - array([2, 3, 5])
 - array([2, 3])
 - array([1, 2, 4])
-

What does k stand for in the example using TAL?

```
<a href="k"  
    tal:attributes="href string:/digit/$el"  
    tal:content="el">SELECTION</a>
```


- literal value for substitution between <a> and
 - a literal value that is replaced by another value when filling in the template
 - variable name for macro substitution in the attribute
 - variable name for macro substitution between <a> and
-

Which Tkinter class corresponds to the button to represent one of the alternative values?

- Button
 - Checkbutton
 - Radiobutton
 - Menubutton
-

In which environment variable is the request method passed (GET, POST, etc.)?

- HTTP_CONNECTION
 - REQUEST_URI
 - QUERY_STRING
 - REQUEST_METHOD
-

What characteristics can be attributed to the Python programming language?

- multi
 - platform/easy to embed in C/C++projects
 - large standard library of modules
-

Which operator corresponds to the following pseudocode:

- | | | |
|---|-----------------|----------|
| 1 | 0 LOAD_FAST | 0 (x) |
| | 3 PRINT_ITEM | |
| | 4 LOAD_FAST | 1 (y) |
| | 7 PRINT_ITEM | |
| | 8 LOAD_CONST | 0 (None) |
| | 11 RETURN_VALUE | |
- def f(x, y): print (x, y)
 - def f(x, y): print x, y
 - def f(x, y): print [x, y]
 - def f(x, y): print x, y,
-

What error was made in the following CGI script code?

```
import cgi

f = cgi.FieldStorage()
if f.has_key("a"):
    v = str(int(f["a"]))
else:
    v = "0"

print " " "Content-Type: text/html\n" " "
print v
```

- FieldStorage object methods used incorrectly
 - user input not checked for security
 - no errors
 - ✓ after receiving f["a"], use the value attribute
-

How can the document:

```
<A><B/><B1/>1<C>2</C></A>
```

Can I get a text element with the value 2?

It is assumed that it is located in the DOM node d.

- ✓ d.lastChild.lastChild.firstChild
 - ✓ d.getElementsByTagName('C')[0].firstChild
 - ✓ d.lastChild.lastChild.lastChild
 - d.childNodes[4]
-

What is the value of the following expression equal to?:

```
shape(array([[1, 2, 3], [4, 5, 6]]).flat)
```

- ✓ (6,)
 - (3,)
 - (3, 2)
 - (2, 3)
-

Which of the following comparisons will necessarily return True if the x and y objects have the same values?

- ✓ x == y
 - id(x) == id(y)
 - ✓ hash(x) == hash(y)
 - x is y
-

What methods do x need to have in order to set the following actions:

```
>>> x = X(0)
>>> print x + 10
10
>>> print x - 23
-23
>>> print x >> 2
0
```

- ✓ __init__, __add__, __sub__, __rshift__
 - __init__, __add__, __radd__, __sub__, __rsub__, __rshift__, __rrshift__
 - __init__, __add__, __sub__, __rshift__, __str__
 - __init__, __add__, __sub__, __rshift__, __str__, __repr__
-

How can I use the smtplib module to create an SMTP connection to mail. server?

- ✓ c = smtplib.SMTP('mail.server')

```
c = smtplib.sendmail('mail.server', from_, to_, message)
✓ c = smtplib.SMTP(); c.connect('mail.server')
c = smtplib.connect('mail.server')
```

What code generates the following button layout?

```
# 1
b1.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=SE)
b2.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=NE)
b3.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=SW)
b4.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=NW)

# 2
b1.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=SE)
b2.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=NE)
b3.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=SW)
b4.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=NW)

# 3
b1.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=NW)
b2.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=SW)
b3.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=NE)
b4.place(relx=0.2, rely=0.2, relwidth=0.4, relheight=0.4, anchor=SE)

# 4
b1.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=NW)
b2.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=SW)
b3.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=NE)
b4.place(relx=0.5, rely=0.5, relwidth=0.4, relheight=0.4, anchor=SE)
```

2
 1
 4
 3

What exception should be thrown by a DB-API 2.0-compatible module in case of an error that violates the integrity of the database?

DataError
 IntegrityError
 InterfaceError
 OperationalError

How do I get the contents of a file passed to the web server via a form in a CGI script?

read from a file whose name is set in the FILE_NAME environment variable
 read from standard output
 from the file attribute of the FieldStorage object of the FieldStorage object
 read the file attribute of the FieldStorage object FieldStorage методами using the read() or readlines() methods

What would be the name of a standard Python module for working with the IMAP protocol?

imaplib

imap_module
libimap
IMAPLibrary

What code generates the following button layout?

```
# 1
b1.grid(row=0, column=0, rowspan=2)
b2.grid(row=0, column=1)
b3.grid(row=1, column=1)

# 2
b1.grid(row=0, column=0, columnspan=2)
b2.grid(row=1, column=0)
b3.grid(row=1, column=1)

# 3
b1.grid(row=1, column=1, rowspan=2)
b2.grid(row=1, column=0)
b3.grid(row=0, column=0)

# 4
b1.grid(row=1, column=1, columnspan=2)
b2.grid(row=0, column=1)
b3.grid(row=0, column=0)
```

- 1
 - 3
 - 2
 - 4
-

Which of these statements about Python are correct?

- The Python language is used for rapid application development
 - Python has an extensive library of standard modules
 - Python uses intermediate code
 - Python programs are translated into machine code, which is then executed
-

What template can be used for an event where the F5 key is pressed while the right mouse button is pressed?

- <B3-F5>
 - <Button3-F5>
 - <B-F5>
 - <ButtonPress-F5>
-

What function can I use to prepare text for HTML output?

- cgi.unescape()
 - cgi.escape()
 - urllib.quote()
 - urllib.quote_plus()
-

What level of the open system interaction model does the HTTP protocol belong to?

	views
	to a network user
views to the network application layer session transport layer	applications
	session key
	to a transport company

What regular expression can be used to "read" a date in the format YYYY-MM-DD from a string? (you need not only to match the string with a regular expression, but also to get the data: year, month, day)

- `(\d{4})-(\d{2})-(\d{2})`
 - `([0-9]{4})-([0-9]{2})-([0-9]{2})`
 - `([0-9]{4})-([0-9]{2}))^{2}`
 - `([0-9]{4})(-[0-9]{2})^{2}`
-

What paradigms does Python not support?

- structural style
 - hybrid paradigms
 - logic programming
 - modular programming
-

Which module of the Python standard library provides more urllibadvanced high-level functionality than urllib when working with WWW?

- htmllib
 - urlparse
 - urllib2
 - httplib
-

Fundamentals of neural network theory

A network without feedbacks is called a network,

	all layers of which
are connected hierarchically	, and which does not have synaptic connections going from the output of a certain neuron to the inputs of the same neuron or a neuron from the previous layer
	that has synaptic connections

Which networks are characterized by lack of memory?

- single layer
 - multi layer
 - with feedbacks
 - No feedbacks
-

The input of the perceptron are:

- vector consisting of real numbers
 - values 0 and 1
 - vector consisting of zeros and ones
 - the entire real axis (-?;+?)
-

The two-layer perceptron theorem states that:

- in any multi-layer perceptron, only two layers
 - can be trained perceptrons with no more than two layers have the ability to learn
 - any multi-layer perceptron can be represented as a two-layer perceptron
-

Training is called:

- the procedure for calculating threshold values for activation functions
 - the procedure for adjusting neuron signals
 - the procedure for adjusting weight values
-

A neural network is trained if:

- when a certain vector is fed to the input, the network will give an answer to which class of vectors it belongs
 - to. when training inputs are started, it gives the corresponding training outputs
 - . the training algorithm has completed its work and has not looped
-

We feed the vector a to the input of the perceptron. When should the weight values be reduced?

- always when the output is 1

- ✓ if the output is 1, but you need 0
 - if the perceptron signal does not match the desired answer
 - if the output is 0, but you need 1
-

The backpropagation algorithm ends when:

- the value δ becomes below the specified threshold
 - the value of δw for each neuron becomes below the specified threshold
 - ✓ the error signal becomes below the specified threshold
-

The pulse method consists of:

- using second-order derivatives
 - ✓ adding to the weight correction a value proportional to the value of the previous weight change
 - multiplying the weight correction by a value proportional to the value of the previous weight change
-

Network paralysis can occur when:

- ✓ weight values become very large
 - step size becomes very large
 - step size becomes very small
 - weight values become very small
-

If the network has a very large number of neurons in hidden layers, then:

- the time required for network training is minimal
 - ✓ network retraining is possible
 - the network may not be flexible enough to solve the task at hand
-

The discriminant function is called:

- activation function used in a multi-layer perceptron
 - function that simulates the solution space of a given problem
 - ✓ function that is equal to one in the area of the object space where objects from the desired class are located, and equal to zero outside this area
-

In the cross-validation method, it is assumed that a set of learning pairs is correctly divided into two parts if:

- network error on the training set decreases faster than on the control set
 - at the beginning of operation, network errors on the training and control sets differ significantly
 - ✓ at the beginning of operation, network errors on the training and control sets practically did not differ
-

If the network contains two intermediate layers, then it models:

- one convex "weighting" for each hidden element of the first layer
- one "sigmoid slope" for each hidden element

- ✓ one convex "weighting" for each hidden element
 - of the second layer one convex "weighting"
-

The control cross-validation mechanism consists of:

- cyclic use of multiple training pairs
 - dividing the set of training pairs into two parts to run the backpropagation algorithm alternately on one part, then on the other part
 - ✓ reserving a part of the training pairs and using them for independent control of the learning process
-

If the counterpropagation network training algorithm uses a vector x as its input, then the desired output is

- a vector y that is a reference for all vectors that are similar to vector x
 - a binary vector that interprets the class number that vector x belongs to
 - ✓ the vector x itself
-

The "winner" is the Kohonen neuron

- ✓ with the maximum value of the NET
 - value with the minimum value of the NET
 - value with the minimum value of the OUT
 - value with the maximum value of the OUT value
-

If a given Kohonen neuron is a "winner", then its value is OUT

- is the maximum value among all OUT values of Kohonen layer neurons
 - equal to zero
 - ✓ equal to one
-

The accreditation method consists of:

- activating two neurons with the highest and lowest NET values
 - activating a group of Kohonen neurons with the highest NET values
 - ✓ activating only one Kohonen neuron with the highest NET value
-

The strategy for avoiding local minima while maintaining stability is to

- sufficiently large changes in weight values
 - ✓ large initial steps of changing weight values and gradually decreasing these steps
 - small initial steps of changing weight values and gradually increasing these steps
 - sufficiently small changes in weight values
-

Which algorithm is more dangerous for network paralysis?

- back-propagation algorithm
- ✓ Cauchy distribution algorithm

What is the role of artificial temperature in Boltzmann learning?

- to control the rate of convergence of the learning algorithm
 - ✓ as the temperature decreases smaller changes are likely to become possible
-

The Hopfield network is replaced by a Hamming network if:

- it is necessary to speed up the convergence time of the network
 - it is necessary to increase the number of stored samples
 - it is necessary to ensure the stability of the network
 - ✓ there is no need for the network to explicitly output the stored sample
-

What should be the weights of inhibitory synaptic connections?

- ✓ equal values from the interval $(-1/n, 0)$, where n is the number of neurons in one layer
 - with small positive numbers
 - and random negative numbers
-

The method of rejecting synaptic symmetry allows you to:

- ✓ achieve maximum memory capacity
 - ensure network resilience
 - avoid local minima
-

The Boltzmann machine method allows Hopfield networks:

- ✓ avoid local minima
 - speed up the learning process
 - avoid network paralysis
-

A DAP network is called adaptive if:

- ✓ the network changes its weight values during training
 - any neuron can change its state at any time
 - and each neuron has its own threshold function
-

Lotharal-inhibitory coupling is used :

- between comparison and recognition layers
 - ✓ inside the recognition layer
 - inside receiver 1
 - inside receiver 2
-

The process of lateral inhibition ensures that

	reset layer removes excitation from an unsuccessfully selected neuron in
the recognition layer✓	only the neuron whose convolution is maximal is excited
	in the recognition layer the system automatically decides whether to stop searching for the necessary information

If some weight was set to zero during the training process, then:

- ✓ it will never accept a non zero value
 - again it will definitely be subjected to new training
-

The weight increment of the inhibitory input of a given postsynaptic neuron depends on:

- output of the inhibitory presynaptic neuron and its excitatory weight
 - output of the excitatory presynaptic neuron and its inhibitory weight
 - ✓ output of the excitatory presynaptic neuron and its excitatory weight
-

What is the difference between complex nodes lying in different layers of the neocognitron?

- ✓ each layer of complex nodes responds to more input image transformations than the previous one
 - ✓ each layer of complex nodes responds to a wider field area of the input image than the previous one
-

What type of training can be used to train a neocognitron?

- ✓ "learning without a teacher"
 - ✓ "learning with a teacher"
-

Perceptron training is considered complete when:

- ✓ the output error becomes quite small
 - a fairly accurate approximation of the given function
 - is achieved all vectors of the training set are started once
-

The perceptron learning algorithm is:

- ✓ the "learning with a teacher " algorithm
 - the "learning without a teacher" algorithm
-

Launching the training vector X. In what case do you not need to change the weight values?

- if the output of the network is 1
 - if the output of the network is 0
 - ✓ if the perceptron signal matches the correct answer
-

Can we say in a finite number of steps after starting the perceptron learning algorithm that the perceptron cannot learn this problem?

- no
 - yes
 - depending on the task
-

The error signal of a given output neuron is called:

- difference between the output of a neuron and its target value
 - derivative of the activation function
 - величина OUT value for the neuron that sends a signal to this output neuron
-

The method of accelerating convergence consists in:

- multiplying the weight correction by a value proportional to the value of the previous weight change
 - using second-order derivatives
 - adding a value proportional to the value of the previous weight change to the weight correction
-

If the two samples are very similar, then:

- they can combine into a single sample
 - they can cause cross associations
 - they can disrupt the stability of the network
-

The absence of feedbacks guarantees:

- network stability
 - learning algorithm convergence
 - ability to approximate this function
-

In a generalized Boltzmann machine learning algorithm, the calculation of pinned probabilities starts after:

- start each training pair
 - of a finite number of network runs from some random value
 - after starting all training pairs
 - after starting the network once from some random value
-

In an analog-to-digital converter, the weight values are interpreted:

- Amplifiers
 - Resistance
 - voltage
-

If the input vector corresponds to one of the stored images, then:

the output of the recognition layer is the corresponding stored sample

✓ one neuron is excited in the recognition layer

and the reset block is triggered

If repeated sequences of training vectors are fed to the network input during the training process, then:

there will be a cyclic change in weights

with each new repetition of a series of training vectors more fine tuning of the weight values will occur

✓ after a finite number of training series the learning process will stabilize

In statistical learning algorithms, the amount of change in synaptic communication between two neurons depends on:

from the difference between the real and desired neuron outputs

from the level of excitation of the presynaptic neuron

from the level of excitation of the postsynaptic neuron

✓ changes randomly

With a single-neuron perceptron, the dimension of the shared space is determined by

the context of a particular task

weight values

✓ and the length of the input vector

threshold value of the activation function

A single-layer perceptron solves problems:

✓ approximations

of pattern recognition functions

✓ classifications

The perceptron learning theorem states that:

✓ if the given problem is not representable by a perceptron, then the learning algorithm loops

if the problem has no solution, then the learning algorithm loops

any learning algorithm loops

Is it possible to train all neurons of a multilayer perceptron?

only neurons of the first layer

yes

✓ only neurons of the last layer

The cross-validation method assumes that the network has started to retrain if:

the network error on the control set began to grow

the backpropagation algorithm was looped

✓ the network error on the control set stopped decreasing

A deterministic training method is called:

method that performs pseudo-random changes in weight values

deterministic method of learning with a teacher

deterministic method of learning without a teacher

✓ method that uses sequential correction of weights depending on the objective values of the network

Is there a chance that the network will "forget" the correct image in the unlearning algorithm?

✓ yes

no

depending on the task

In the traveling salesman problem, each city is represented by:

one layer

of neurons, or a string of n neurons, where n is the number of cities

with one neuron

How does the reaction of a complex node to a given input image differ from the reaction of a simple node lying in the same layer?

✓ the complex node is less sensitive to the position of the input image

the receptor zone of the complex node is much larger than the receptor zone of the simple node

the complex node is less sensitive to rotation and other types of movement of the input image

The output of the Grossberg output star is

measure of similarity of the input vector with the weight vector

class number of similar images

✓ static characteristic of the training set

Artificial neuron

✓ simulates the basic functions of a biological neuron

it is superior in its functionality to a biological neuron

it is a model of a biological neuron

To avoid network paralysis, you must:

✓ reduce step size increase step

size

increase weight values

decrease weight values

In a single-neuron perceptron, the dimension of the separating hyperplane is defined by:

- the number of input values
 - weight values
 - the number of output values
-

At the initial time, the output of the speech recognition layer is:

- zero vector
 - unit vector
 - input vector
-

The activation function is called:

- function that sums up the input signals of a neuron
 - function that calculates the output signal of a neuron
 - function that distributes input signals to neurons
 - function that corrects weight values
-

A memory is called heteroassociative if:

- the input image can be assigned to a certain class of images
 - the input image can only be completed or corrected
 - the input image can be associated with another image
-

Memory is called associative if the necessary information is extracted using:

- by the content of this information
 - available samples
 - address of the starting point of this information
-

Weight values of inhibitory neurons:

- trained by the delta rule
 - trained by an algorithm similar to the backpropagation algorithm
 - not trained
-

Adding a value proportional to the previous weight change to the weight correction is used in the method:

- pulse
 - exponential smoothing
 - convergence acceleration
 - adding neural bias
-

The speech recognition phase is being initialized:

- when the reset layer is triggered
 - when the winning neuron in the recognition layer is excited
 - ✓ when the input vector is applied to the input
-

Association encoding is:

- ✓ "learning with a teacher"
 - the process of normal network functioning
 - "learning without a teacher"
-

In statistical learning algorithms, artificial temperature is used for:

- ✓ controlling the size of random changes in weight values
 - minimizing the objective function
 - reducing the total network energy
-

In the stochastic learning method, if the objective function increases, then:

- ✓ changes to the weight values are discarded and new calculations
 - are performed it is announced that the network cannot learn this problem
 - repeated changes to the weight values are made
-

What is the difference between ART-1 and ART-2?

- in ART-2, a multi-layered hierarchy of layers is used
 - in ART-2, a special mechanism for the dependence of synapse activity on time is introduced
 - ✓ ART-1 processes only bit signals, while ART-2 processes analog signals
-

When training a cognitron, they learn:

- all neurons
 - only one neuron in each layer
 - ✓ only one neuron in each competition area
-

Which of the following steps in the backpropagation algorithm are the "forward pass" steps?

- ✓ calculate the network output
 - adjust the network weights to minimize the error
 - ✓ select the next training pair from the training set; feed the input vector to the network input
 - repeat steps 1 to 4 for each vector of the training set until the error on the entire set reaches an acceptable level
 - calculate the difference between the network output and the required output (target vector of the training pair)
-

From the comparison layer, information is sent to:

- receiver 2
 - ✓ recognition layer
 - Receiver 1
 - external environment
 - ✓ reset layer
-

Training a counter-propagation network is:

- "learning without a teacher"
 - ✓ "learning with a teacher"
-

With a stochastic training method, changes in the weight values are preserved if

- ✓ they decrease the objective function
 - they increase the objective function
 - anyway
-

In what case can the perceptron learn to solve this problem?

- if the problem has an integer numerical solution
 - ✓ if the problem is representable by a perceptron
 - if the problem has a solution
-

The similar perceptron theorem states that:

- there will be problems that the perceptrons cannot
 - learn the learning algorithm always converges
 - ✓ if this problem represents a perceptron, then it is able to learn it
-

Direct distribution networks are:

- ✓ networks that have no memory
 - ✓ networks that have no connections going from the outputs of a certain layer to the inputs of the previous layer
 - networks that have memory
 - networks that have many layers
-

A DAP network is called inhomogeneous if:

- ✓ each neuron has its own threshold function
 - you can assign several alternative associations to this input vector
 - the associated vectors have different dimensions
-

What type of memory does the DAP belong to?

- addressable

autoassociative

✓ heteroassociative

If the Hopfield network has found among its stored samples a sample corresponding to the given input vector, then the network must :

output the specified input vector

✓ stop in this sample

output a unit at the output

How can we reduce the number of layers of a cognitron without compromising its computational properties?

by introducing probabilistic synoptic connections

by moving from one-dimensional layers to two-dimensional layers

✓ by expanding the connection areas in subsequent layers

Self-organizing networks are used for:

✓ pattern recognition

function approximation

✓ image classification

Receptive regions of nodes in each plane of simple nodes

do not intersect, but cover the entire field of the input image

match and cover the entire field of the input image

✓ do not intersect and cover the entire field of the input image

In what case does the OUT signal coincide with the NET signal for a given cognitron neuron?

if NET=0

✓ if NET>0

if NET??Where? — set threshold value

Single-neuron perceptron with two inputs:

selects a closed region

divides the three dimensional XOY space into two half

spaces ✓ divides the XOY plane into two half planes

The method for restoring associations is that:

it is determined whether two given vectors are mutually associated

✓ a partially noisy vector is used to restore the vector associated with it

associations are found for the given vectors that connect them

How many neurons are needed to implement the traveling salesman problem, where n is the number of cities?

- $2n$ neurons
 - $n!$ neurons
 - n^2 neurons
 - n neurons
-

The value of the activation function is:

- output of this neuron
 - weight value of this neuron
 - input of this neuron
-

When training a perceptron, training is assumed:

- synoptic connections connecting simultaneously excited neurons
 - synoptic connections of only the "winning" neuron
 - and all synoptic connections
-

The search phase is considered completed successfully if:

- there is a neuron that stores an image that is sufficiently similar to the input image
 - the weight values of the "winning" neuron from the recognition layer will be corrected according to this input vector
 - the input image will be mapped to a neuron in which no information has yet been stored
-

If all the weight values of the network are made equal before starting the training procedure using the backpropagation algorithm, then

- the learning process will be accelerated
 - the network will most likely not learn
 - The learning process will be slowed down
-

Modification of the learning algorithm by the "sense of justice" method consists in:

- blocking neurons that very often win
 - lowering the weight values of those neurons that very often "win"
 - increasing the weight values of those neurons that very rarely "win"
-

The hidden layer of a generalized multilayer perceptron is called:

- a layer that is neither input nor output
 - a layer that does not perform calculations
 - a layer consisting of elements that only accept input information and distribute it over the network
-

Orthogonalization of the source images allows you to:

avoid local minima
✓ Ensure network resilience
✓ Achieve maximum memory capacity

Evaluation criteria (in points):

- **5 points** are awarded to the student if the student has given complete, detailed answers to all theoretical questions, demonstrated knowledge of functional capabilities, terminology, basic elements, and the ability to apply theoretical knowledge in performing practical tasks. The student easily answered all the additional questions. The practical part of the work was completed completely without any inaccuracies or errors.

- **4 points** is awarded to the student if the student has covered mainly theoretical questions, but there are inaccuracies in the definition of basic concepts. Some minor inaccuracies were made when answering additional questions. Minor mistakes were made when performing the practical part of the work.

- **3 points** are awarded to the student if the student makes several significant errors in the interpretation of basic concepts when answering theoretical questions. The logic and completeness of the answer suffer from noticeable flaws. There are noticeable gaps in knowledge of the main methods. Theoretical questions are generally presented sufficiently, but with omissions of material. There are fundamental errors in the logic of constructing the answer to the question. The student did not solve the problem or made some serious mistakes.

- **1-2 points** are awarded to the student if the answer to theoretical questions indicates a lack of understanding and extremely incomplete knowledge of basic concepts and methods. There is a lack of skills in applying theoretical knowledge in performing practical tasks. The student could not answer any additional questions.

Tasks for laboratory work

Laboratory work #1: "Linear programs".

Write a program to calculate using two formulas. Prepare at least five test cases. Express the missing functions in the language in terms of the existing ones.

$$0 \quad z_1 = 2 \sin^2(3\pi - 2\alpha) \cdot \cos^2(5\pi + 2\alpha);$$

$$z_2 = \frac{1}{4} - \frac{1}{4} \sin\left(\frac{5}{2}\pi - 8\alpha\right).$$

$$1 \quad z_1 = \cos \alpha + \sin \alpha + \cos 3\alpha + \sin 3\alpha;$$

$$z_2 = 2\sqrt{2} \cos \alpha \cdot \sin\left(\frac{\pi}{4} + 2\alpha\right).$$

$$2 \quad z_1 = \frac{\sin 2\alpha + \sin 5\alpha - \sin 3\alpha}{\cos \alpha + 1 - 2 \sin^2 2\alpha}; \quad z_2 = 2 \sin \alpha.$$

$$3 \quad z_1 = \frac{2 \cdot \cos \alpha \cdot \sin 2\alpha - \sin \alpha}{\cos \alpha - 2 \cdot \sin \alpha \cdot \sin 2\alpha}; \quad z_2 = \operatorname{tg} 3\alpha.$$

$$4 \quad z_1 = 1 - \frac{1}{4} \sin^2 2\alpha + \cos 2\alpha; \quad z_2 = \cos^2 \alpha + \cos^4 \alpha.$$

$$5 \quad z_1 = \cos \alpha + \cos 2\alpha + \cos 6\alpha + \cos 7\alpha;$$

$$z_2 = 4 \cos \frac{\alpha}{2} \cdot \cos \frac{5}{2} \alpha \cdot \cos 4\alpha.$$

$$6 \quad z_1 = \cos^2\left(\frac{3}{8}\pi - \frac{\alpha}{4}\right) - \cos^2\left(\frac{11}{8}\pi + \frac{\alpha}{4}\right); \quad z_2 = \frac{\sqrt{2}}{2} \sin \frac{\alpha}{2}.$$

$$7 \quad z_1 = \cos^4 x + \sin^2 y + \frac{1}{4} \sin^2 2x - 1;$$

$$z_2 = \sin(y+x) \cdot \sin(y-x).$$

$$8 \quad z_1 = (\cos \alpha - \cos \beta)^2 - (\sin \alpha - \sin \beta)^2;$$

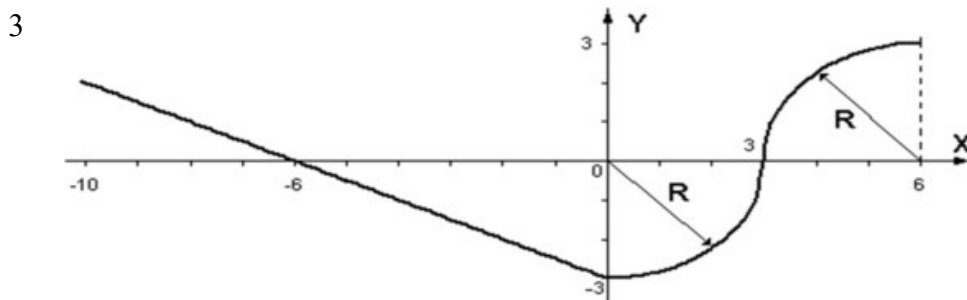
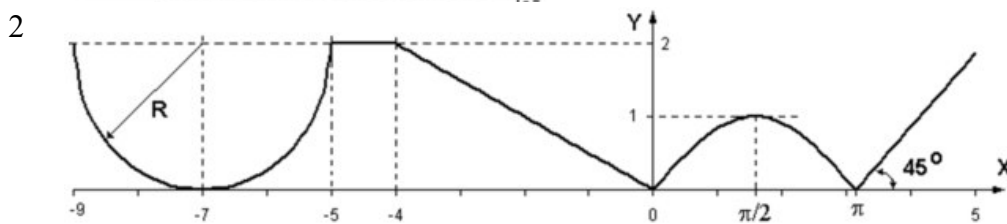
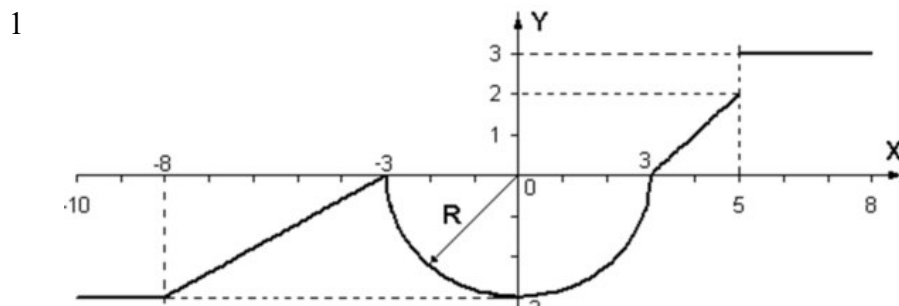
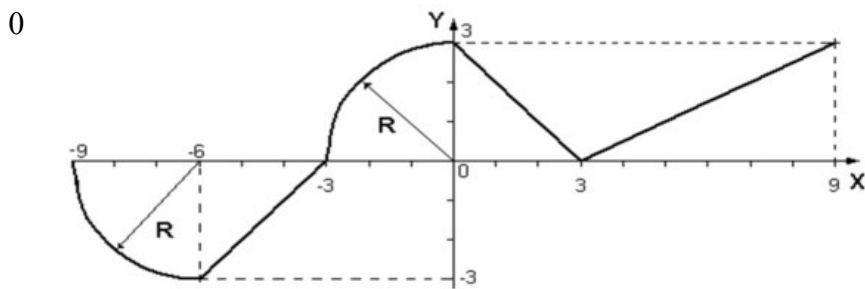
$$z_2 = -4 \sin^2 \frac{\alpha - \beta}{2} \cdot \cos(\alpha + \beta).$$

$$9 \quad z_1 = \frac{1 - 2 \sin^2 \alpha}{1 + \sin 2\alpha}; \quad z_2 = \frac{1 - \operatorname{tg} \alpha}{1 + \operatorname{tg} \alpha}.$$

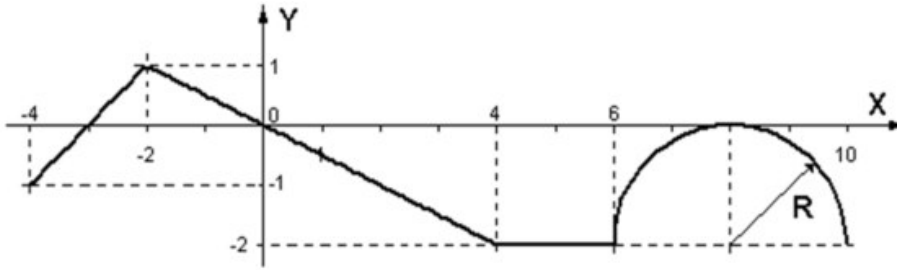
Laboratory work #2: "Branching computing processes".

Task 1.

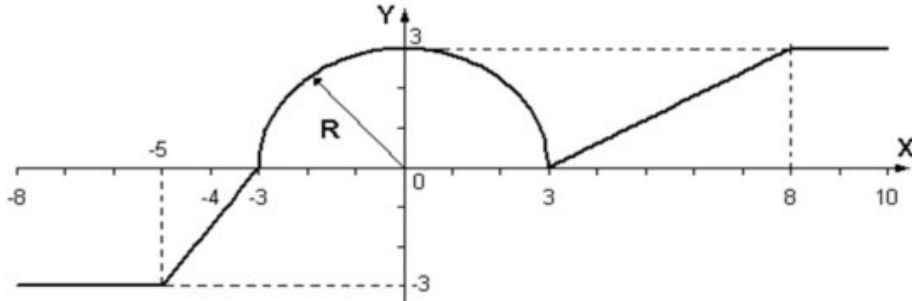
Write a program that calculates the value of a function defined as a graph based on the entered argument value. The parameters required for solving the task should be obtained from the schedule and defined in the program.



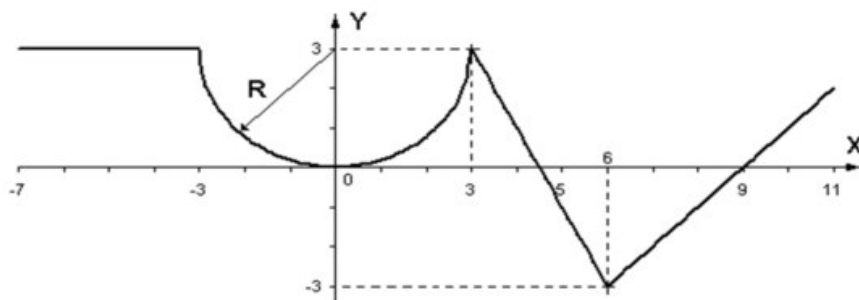
4



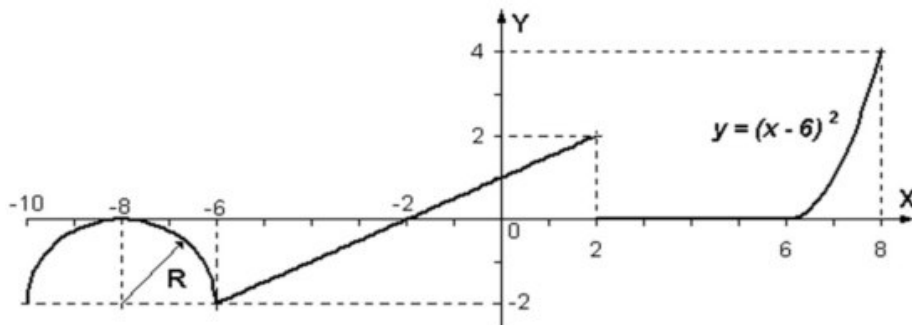
5



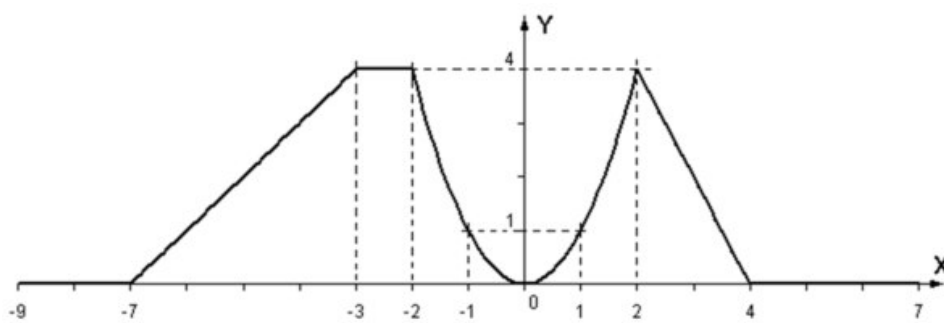
6



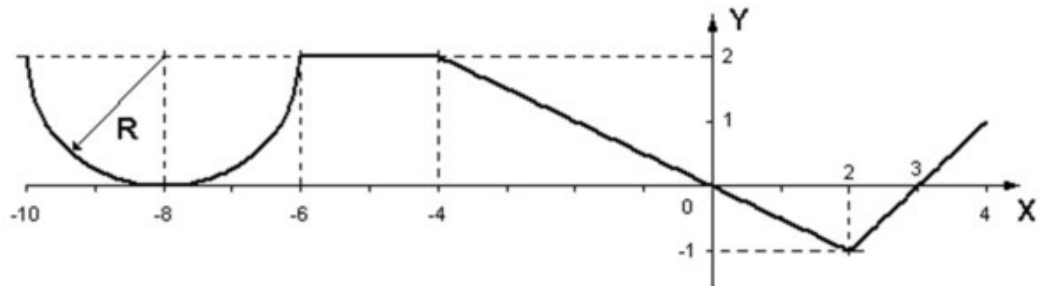
7



8



9

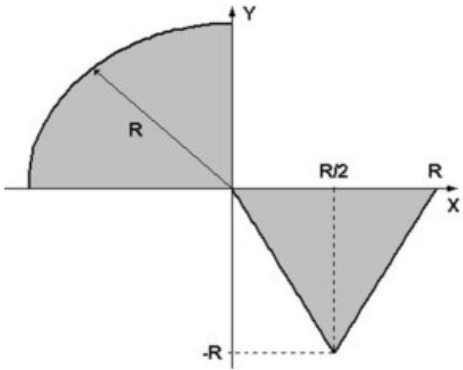


Task 2.

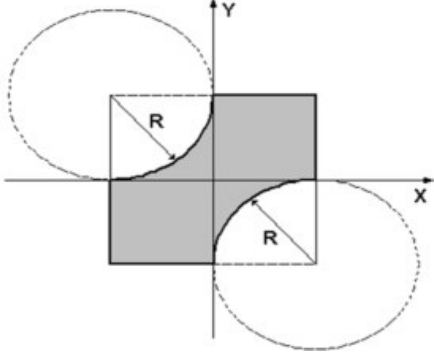
Write a program that determines whether a point with the specified X, Y coordinates falls into the

area that is grayed out in the drawing. Output the result of the program as a text message. R Enter the R parameter using the keyboard.

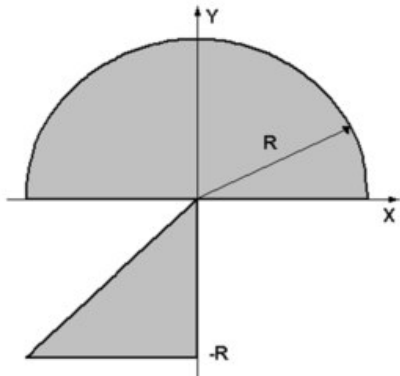
0



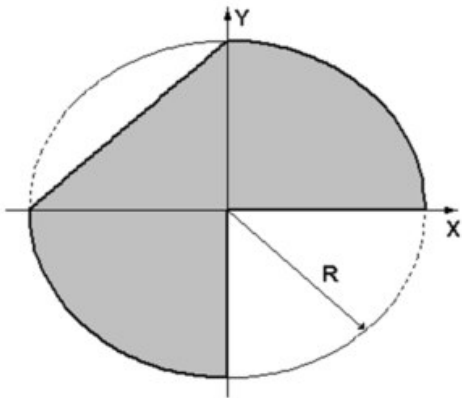
1



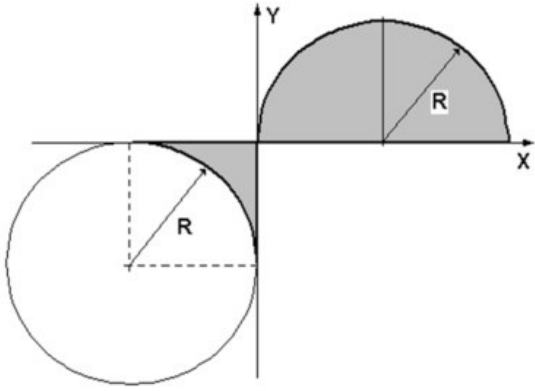
2



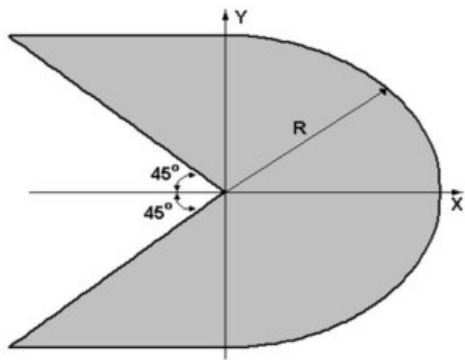
3



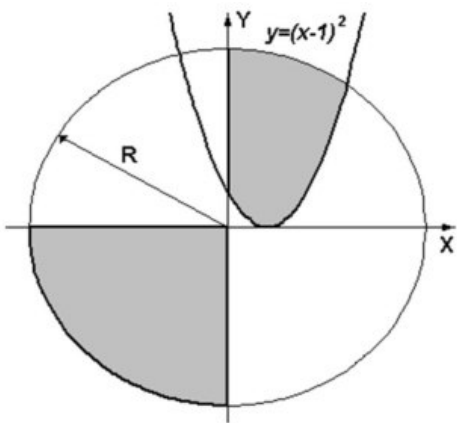
4



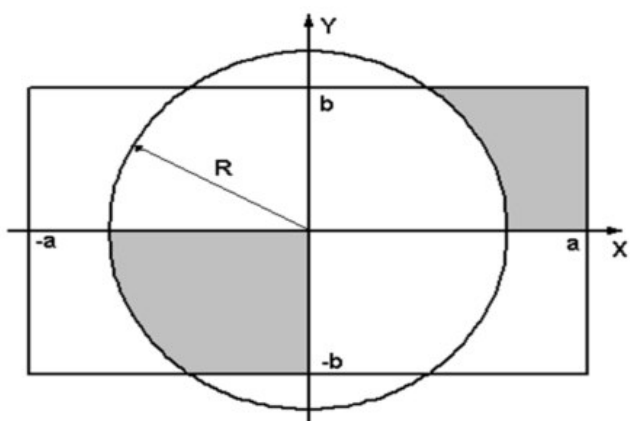
5



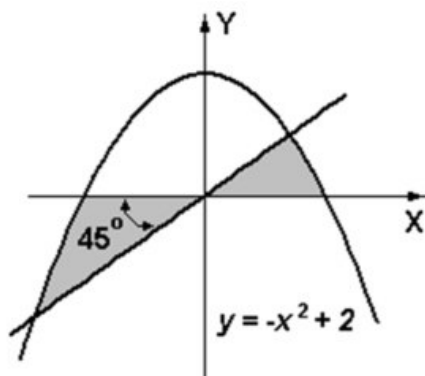
6



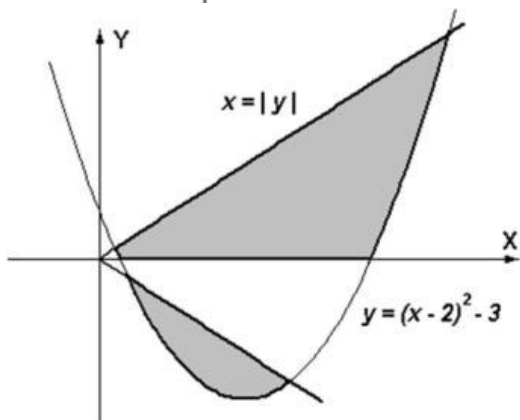
7



8



9



Laboratory work #3: "Organization of cycles".

Task 1.

Calculate and display on the screen as a table the values of the function specified graphically (see task 1 of laboratory work # 2), in the interval from X_{nach} to X_{kon} с шагом X_{con} in dx increments. Set the interval and step so that all branches of the program are checked. Add a title and header to the table.

Task 2.

For ten shots whose coordinates are set by the random number generator, print text messages about hitting the target (see lab # 2, task 2).

Task 3.

Calculate and display as a table the values of the function defined using the Taylor series in the interval from X_{nach} to X_{con} in increments of dx with an accuracy of ε .

Add a title and header to the table. Each row of the table must contain the value of the argument, the value of the function, and the number of summed members of the series.

$$0 \quad \ln \frac{x+1}{x-1} = 2 \cdot \sum_{n=0}^{\infty} \frac{1}{(2 \cdot n + 1) \cdot x^{2n+1}} = 2 \cdot \left(\frac{1}{x} + \frac{1}{3 \cdot x^3} + \frac{1}{5 \cdot x^5} + \dots \right), \quad |x| > 1.$$

$$1 \quad e^{-x} = \sum_{n=0}^{\infty} \frac{(-1)^n \cdot x^n}{n!} = 1 - x + \frac{x^2}{2!} - \frac{x^3}{3!} + \frac{x^4}{4!} - \dots, \quad |x| < \infty.$$

$$2 \quad e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \dots, \quad |x| < \infty.$$

$$3 \quad \ln(x+1) = \sum_{n=0}^{\infty} \frac{(-1)^n \cdot x^{n+1}}{n+1} = x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \dots, \quad -1 < x \leq 1.$$

$$4 \quad \ln \frac{1+x}{1-x} = 2 \cdot \sum_{n=0}^{\infty} \frac{x^{2n+1}}{2 \cdot n + 1} = 2 \cdot \left(x + \frac{x^3}{3} + \frac{x^5}{5} + \dots \right), \quad |x| < 1.$$

$$\begin{aligned}
5 \quad \ln(1-x) &= -\sum_{n=1}^{\infty} \frac{x^n}{n} = -\left(x + \frac{x^2}{2} + \frac{x^3}{3} + \dots\right), & -1 \leq x < 1. \\
6 \quad \operatorname{arccot} x &= \frac{\pi}{2} + \sum_{n=0}^{\infty} \frac{(-1)^{n+1} \cdot x^{2n+1}}{2 \cdot n + 1} = \frac{\pi}{2} - x + \frac{x^3}{3} - \frac{x^5}{5} + \dots, & x \leq 1. \\
7 \quad \operatorname{arctg} x &= \frac{\pi}{2} + \sum_{n=0}^{\infty} \frac{(-1)^{n+1}}{(2 \cdot n + 1) \cdot x^{2n+1}} = \frac{\pi}{2} - \frac{1}{x} + \frac{1}{3 \cdot x^3} - \frac{1}{5 \cdot x^5} + \dots, & x > 1. \\
8 \quad \operatorname{arctg} x &= \sum_{n=0}^{\infty} \frac{(-1)^{n+1} \cdot x^{2n+1}}{(2 \cdot n + 1)} = x - \frac{x^3}{3} + \frac{x^5}{5} - \frac{x^7}{7} + \dots, & |x| \leq 1. \\
9 \quad \operatorname{arctg} x &= -\frac{\pi}{2} + \sum_{n=0}^{\infty} \frac{(-1)^{n+1}}{(2 \cdot n + 1) \cdot x^{2n+1}} = -\frac{\pi}{2} - \frac{1}{x} + \frac{1}{3 \cdot x^3} - \frac{1}{5 \cdot x^5} + \dots, & x < -1.
\end{aligned}$$

Laboratory work #4: "One-dimensional arrays".

- 0 In a one-dimensional array consisting of n real elements, calculate:
 1. The sum of negative elements.
 2. Product of elements located between the maximum and minimum elements.

Arrange the array elements in ascending order.
- 1 In a one-dimensional array consisting of n real elements, calculate:
 1. The sum of positive elements.
 2. Product of elements located between the maximum modulo and minimum modulo elements.

Arrange the array elements in descending order.
- 2 In a one-dimensional array consisting of n integer elements, calculate:
 1. Product of elements with even numbers.
 2. The sum of elements located between the first and last zero elements.

Convert the array so that all positive elements are located first, and then all negative ones (elements equal to zero are considered positive).
- 3 In a one-dimensional array consisting of n real elements, calculate:
 1. The sum of elements with odd numbers.
 2. The sum of elements located between the first and last negative elements. Compress an array by removing all elements whose modulus does not exceed one. Fill in the elements that are released at the end of the array with zeros.
- 4 In a one-dimensional array consisting of n real elements, calculate:
 1. Maximum element of the array.
 2. The sum of elements located up to the last positive element.

Compress the array by removing all elements whose modulus is in the interval $[a, b]$. Fill in the elements that are released at the end of the array with zeros.
- 5 In a one-dimensional array consisting of n real elements, calculate:
 1. Minimum element of the array.
 2. The sum of elements located between the first and last positive elements.

Convert the array so that all elements equal to zero are located first, and then all the others.
- 6 In a one-dimensional array consisting of n integer elements, calculate:
 1. Number of the maximum array element.
 2. Product of array elements located between the first and second null elements.

Convert the array so that the first half contains elements that were in odd positions, and the second half contains elements that were in even positions.
- 7 In a one-dimensional array consisting of n real elements, calculate:
 1. Number of the minimum element.
 2. The sum of elements located between the first and second negative elements.

Convert the array so that all elements whose modulus does not exceed one are located first, and then all the others.

- 8 In a one-dimensional array consisting of n real elements, calculate:
 1. Maximum modulo element.
 2. The sum of elements located between the first and second positive elements. Convert the array so that elements equal to zero are placed after all the others.
- 9 In a one-dimensional array consisting of n integer elements, calculate:
 1. Minimum modulo element.
 2. The sum of modules of elements located after the first element, equal to zero.
 Convert the array so that the first half contains elements that were in even positions, and the second half contains elements that were in odd positions.

Laboratory work #5: "Two-dimensional arrays and functions. The NumPy library".

The dimensions of two-dimensional arrays should be requested from the user. All necessary data must be passed to functions as parameters; all variables used only within the function must be described as local.

Use of global variables in functions is not allowed. Provide output of both the original array and the array obtained as a result of the program, where possible according to the task condition.

Assign task items as functions.

- 0 An integer rectangular matrix is given. Define:
 1. The number of rows that do not contain any null elements.
 2. Maximum value of numbers that occur more than once in a given matrix.
- 1 An integer rectangular matrix is given.
 1. Determine the number of columns that do not contain any null elements.
 2. When rearranging the rows of a given matrix, arrange them according to the growth of characteristics.

NOTE: The row characteristic of an integer matrix is the sum of its positive even elements.
- 2 An integer rectangular matrix is given. Define:
 1. The number of columns containing at least one null element.
 2. Number of the line that contains the longest series of identical elements.
- 3 An integer square matrix is given. Define:
 1. The product of elements in those rows that do not contain negative elements.
 2. Maximum among the sums of elements of diagonals parallel to the main diagonal of the matrix.
- 4 An integer square matrix is given. Define:
 1. The sum of elements in those columns that do not contain negative elements.
 2. Minimum among the sums of modules of elements of diagonals parallel to the side diagonal of the matrix.
- 5 An integer rectangular matrix is given. Define:
 1. The sum of elements in those rows that contain at least one negative element.
 2. Row and column numbers of all saddle points in the matrix.

NOTE: A matrix A has a saddle point A_{ij} if A_{ij} is the minimum element in the i -th row and the maximum element in the j -th column.
- 6 For a given matrix of size 8×8 , find k such that the elements of the k th row of the matrix coincide with the elements of the k th column.
Find the sum of elements in those rows that contain at least one negative element.
- 7 When rearranging the columns of a given matrix, arrange them according to the growth of characteristics.
Find the sum of elements in those columns that contain at least one negative element.
NOTE: The characteristic of a column of an integer matrix is the sum of the modules of its negative odd elements.
- 8 The coefficients of a system of linear equations are given as a rectangular matrix. Use valid transformations to convert the system to a triangular shape.
Find the number of rows whose arithmetic mean of elements is less than the specified value.
- 9 Compact the specified matrix by removing rows and columns filled with zeros.
Find the number of the first row containing at least one positive element.

Lab # 6: "Working with files in Python"

Make adjustments to programs written for laboratory work #1, # 4, and # 5, so that data entry and output of work results are performed using files.

Lab # 7: "The SymPy Library. Differentiation, integration, and calculation of limits. Solving ordinary differential equations.»

Task 1.

1. Find the derivative:

1.1. $\arcsin(x)$; $x^2 \cdot e^x$;

1.2. $\arccos(x)$; $x^3 \cdot \operatorname{arctg}(x)$;

1.3. $\operatorname{arctg}(x)$; $x \cdot \sqrt{x} \cdot (3 \cdot \ln(x) - 2)$;

1.4. $\operatorname{arcctg}(x)$; $\left(\frac{\arcsin(x)}{x}\right)$;

1.5. $\operatorname{sh}(x)$; $\left(\frac{\sin(x) - \cos(x)}{\sin(x) + \cos(x)}\right)$;

1.6. $\operatorname{ch}(x)$; $(2 \cdot x^3 + 5)^4$;

1.13. $\operatorname{tg}(x)$; $\ln\left(\operatorname{tg}\left(\frac{x}{2}\right)\right)$.

1.7. $\operatorname{th}(x)$; $\operatorname{tg}^6(x)$;

1.8. $\operatorname{cth}(x)$; $\cos^2(x)$;

1.9. \sqrt{x} ; $\sin(2x + 3)$;

1.10. a^x ; $\operatorname{tg}(\ln(x))$;

1.11. $\ln(x)$; $\sin^3\left(\frac{x}{3}\right)$;

1.12. $\log_a(x)$; $\ln(x^2 + 5)$;

2. Find the integral:

2.1. $\int \frac{dx}{\sin^2 x}$, $\int_0^1 \frac{dx}{1+x+x^3}$,

2.7. $\int \frac{\sin x dx}{1 + \sin x}$, $\int_0^{\pi/2} \cos^2 x dx$,

2.2. $\int \frac{x dx}{\sin^2 x}$, $\int_0^1 \frac{dx}{1-x+x^3}$,

2.8. $\int \frac{\sin x dx}{1 - \sin x}$, $\int_0^{\pi/2} \sin^2 mx dx$ when $m = 1, 2, \dots$,

2.3. $\int \frac{dx}{\sin^3 x}$, $\int_0^{\infty} \frac{dx}{(1+x)\sqrt{x}}$,

2.9. $\int \frac{dx}{1 - \sin^2 x}$, $\int_0^{\pi} \sin^2 x dx$,

2.4. $\int \frac{dx}{\sin^4 x}$, $\int_0^{\infty} \left(\frac{1}{1+x^2} - \frac{1}{1+x}\right) \frac{dx}{x}$, 2.10. $\int \frac{dx}{\cos^2 x}$, $\int_0^{\pi} \sin^2 mx dx$ when $m = 1, 2, \dots$,

2.5. $\int \frac{dx}{1 + \sin x}$, $\int_0^{\infty} \frac{dx}{ax^4 + 2bx^2 + a}$,
by $a > 0, c > 0, h > 0$,

2.11. $\int x^2 \cos x dx$, $\int_0^{2\pi} \sin^2 mx dx$ when $m = 1, 2, \dots$

2.6. $\int \frac{dx}{1 - \sin x}$, $\int_0^{\pi/2} \sin^2 x dx$,

2.12. $\int \cos^2 x dx$, $\int_0^{\pi} \frac{dx}{1 + a \cos x}$,

2.13. $\int \frac{dx}{1 + \cos x}$, $\int_0^{2\pi} \frac{dx}{1 + a \sin x}$.

3. Find the following limits:

$$3.1. \lim_{x \rightarrow 4} \frac{5x+2}{2x+3}, \quad \lim_{x \rightarrow 2} \frac{x^2-6x+8}{x^2-8x+12};$$

$$3.2. \lim_{x \rightarrow \infty} \frac{3x+5}{2x+7}, \quad \lim_{x \rightarrow 0} \frac{\sqrt{1+x+x^2}-\sqrt{1-x+x^3}}{x^2-x};$$

$$3.3. \lim_{x \rightarrow 3} \frac{x^2-9}{x^2-3x}, \quad \lim_{x \rightarrow 3} \frac{x^2-5x+6}{x^2-9};$$

$$3.4. \lim_{x \rightarrow 1} \frac{x^3-x^2-x+1}{x^3+x^2-x-1}, \quad \lim_{x \rightarrow 1} \frac{x^3-6x^2+11x-6}{x^2-3x+2};$$

$$3.5. \lim_{x \rightarrow 10} \frac{x^3-1000}{x^3-20x^2+100x}, \quad \lim_{h \rightarrow 0} \frac{\sin(a+2h)-2\sin(a+h)+\sin(a)}{h^2};$$

$$3.6. \lim_{x \rightarrow 0} \frac{\sqrt{x+4}-2}{x}, \quad \lim_{x \rightarrow 0} \frac{\operatorname{tg}(mx)}{\sin(mx)};$$

$$3.7. \lim_{x \rightarrow 0} \frac{\sqrt[5]{(1+x)^3}-1}{x}, \quad \lim_{x \rightarrow x_0} \frac{\operatorname{tg}(x)-\operatorname{tg}(x_0)}{x-x_0};$$

$$3.8. \lim_{x \rightarrow 0} \frac{\sin(mx)}{x}, \quad \lim_{x \rightarrow 2} \frac{x^2-7x+10}{x^2-8x+12};$$

$$3.9. \lim_{x \rightarrow 0} \frac{1-\cos(5x)}{x^2}, \quad \lim_{x \rightarrow 0} \frac{1-\cos(5x)}{1-\cos(3x)};$$

$$3.10. \lim_{x \rightarrow \infty} \frac{x^3+2x^2+3x+4}{4x^3+3x^2+2x+1}, \quad \lim_{x \rightarrow 0} \frac{\operatorname{tg}(x)-\sin(x)}{x^3};$$

$$3.11. \lim_{x \rightarrow \infty} \frac{3x^4-2}{\sqrt{x^8+3x+4}}, \quad \lim_{x \rightarrow 0} \frac{\ln(1+mx)}{x};$$

$$3.12. \lim_{x \rightarrow \infty} (\sqrt{x^2+8x+3} + \sqrt{x^2+4x+3}), \quad \lim_{x \rightarrow \infty} (\sin \sqrt{x+1} - \sin \sqrt{x});$$

$$3.13. \lim_{x \rightarrow \infty} \left(\frac{x^2+5x+4}{x^2-3x+7} \right)^x, \quad \lim_{x \rightarrow \infty} \frac{1-5^x}{1-e^x}.$$

Task options.

- | | |
|---------------------|-------------------------|
| {1}. 1.1; 2.1; 3.1; | {9}. 1.9; 2.9; 3.9; |
| {2}. 1.2; 2.2; 3.2; | {10}. 1.10; 2.10; 3.10; |
| {3}. 1.3; 2.3; 3.3; | {11}. 1.11; 2.11; 3.11; |
| {4}. 1.4; 2.4; 3.4; | {12}. 1.12; 2.12; 3.12; |
| {5}. 1.5; 2.5; 3.5; | {13}. 1.13; 2.13; 3.13; |
| {6}. 1.6; 2.6; 3.6; | {14}. 1.1; 2.2; 3.3; |
| {7}. 1.7; 2.7; 3.7; | {15}. 1.13; 2.12; 3.11. |
| {8}. 1.8; 2.8; 3.8; | |

Task 2.

1. Solve the equations:

$$1.1. x(y^2-4) + y \frac{dy}{dx} = 0;$$

$$1.13. \frac{dy}{dx} + \frac{xy}{1-x^2} = \arcsin(x) + x;$$

- 1.2. $(1+x^2)\frac{dy}{dx} + y = \operatorname{arctg}(x)$;
- 1.3. $y \ln^3 y + \frac{dy}{dx} \sqrt{x+1} = 0, y(-15/16) = e$;
- 1.4. $\frac{dy}{dx} \sqrt{1-x^2} + y = \arcsin(x), y(0) = 0$;
- 1.5. $\frac{dy}{dx} = e^{(x+y)} + e^{(x-y)}, y(0) = 0$;
- 1.6. $\frac{dy}{dx} \sin(x) - y \cos(x) = 1, y(\pi/2) = 0$;
- 1.7. $(1+x^2)\frac{dy}{dx} + y = 0, y(1) = 1$;
- 1.8. $\frac{dy}{dx} - \frac{y}{x-1} = \frac{y^2}{x-1}$;
- 1.9. $\ln(\cos(y)) + x \operatorname{tg}(y) \frac{dy}{dx} = 0$;
- 1.10. $\frac{dy}{dx} = \operatorname{sh}(x+y) + \operatorname{sh}(x-y)$;
- 1.11. $x \frac{dy}{dx} = x e^{(y/x)} + y, y(1) = 0$;
- 1.12. $\frac{dy}{dx} - y \operatorname{th}(x) = \operatorname{ch}^2(x)$;
- 1.14. $\frac{dy}{dx} - \frac{2xy}{1+x^2} = 4 \frac{\sqrt{y}}{\sqrt{1+x^2}} \operatorname{arctg}(x)$;
- 1.15. $x \frac{dy}{dx} - y = x^2 \cos(x)$;
- 1.16. $\frac{dy}{dx} + 2xy = x \exp(-x^2)$;
- 1.17. $\frac{dy}{dx} + \frac{n}{x} y = \frac{a}{x^n}, y(1) = 0$;
- 1.18. $\frac{d^2 y}{dx^2} + k^2 y = 0$;
- 1.19. $\frac{d^2 y}{dx^2} + k^2 y = 0, y(0) = 0, y(1) = 1$;
- 1.20. $\frac{dy}{dx} = \sqrt{x^2 - y} + 2x$;
- 1.21. $\frac{d^2 y}{dx^2} - y = \sin(x) \cdot x$;
- 1.22. $\frac{dy}{dt} + 2t = 0, y(1) = 5$
- 1.23. $\frac{d^2 y}{dt^2} + 5 \cdot \frac{dy}{dt} + 6 \cdot y = 0,$
 $y(0) = 0, \frac{dy}{dt}(0) = 1$
- 1.24. $\frac{d^2 y}{dx^2} + k^2 y = 0, y(0) = 0, \frac{dy}{dx}(0) = 1$

Task options.

- | | |
|------------------|-------------------|
| {1}. 1.1; 1.2; | {8}. 1.12; 1.21; |
| {2}. 1.3; 1.4; | {9}. 1.13; 1.22 |
| {3}. 1.5; 1.6; | {10}. 1.14; 1.23; |
| {4}. 1.7; 1.8; | {11}. 1.15; 1.24; |
| {5}. 1.9; 1.18; | {12}. 1.16; 1.14; |
| {6}. 1.10; 1.19; | {13}. 1.17; 1.15; |
| {7}. 1.11; 1.20; | |

Lab # 8: "matplotlib.Pyplot library. Basic graphical commands".

The results of the program execution from the laboratory work can be arranged in the form of bar charts, pie charts, and other types of diagrams.

Lab # 9: "matplotlib.Pyplot library. Plotting functions in different coordinate systems".

Plot a graph of the function defined in lab # 2.1.

Plot graphs of the function and its expansion using the Taylor formula from laboratory work # 3.3 in one figure.

Lab #10: "The SciPy.integrate library. Numerical integration. Numerical solution of the ODE."

Task 1. Find the solution of the task from laboratory work No. 7.1 item 2 in the form of a numerical function. Print the numerical result on the graph together with the function defined in laboratory work No. 7.1 item 2.

Task 2. Numerical solution of the Cauchy problem.

Option 1.

Flow-type reactor with complete mixing: reaction type $A \rightarrow B \rightarrow C$.

The reactor under consideration (a cylindrical vessel with volume V , equipped with a cooling casing). We will assume that the reaction mixture is completely mixed and that an almost irreversible reaction occurs in the reactor. The volume flow F_A, F_B rates F_a, F_b , and input concentrations A_0 of components A and B of the reaction mixture, the input temperature T_0 , the heat transfer coefficient, the heat transfer surface area, and the heat of reaction are assumed to be constant; the molar concentrations A and B , as well as the temperature of the mixture and cooling medium, do not depend on coordinates and can only be functions of time t . Taking these assumptions into account, the model of a flow reactor in which successive first-order exothermic reactions of type $A \rightarrow B \rightarrow C$ occur can be described using the following three differential equations

$$\begin{aligned} X' &= 1 - X - DaXa(\theta), \\ Y' &= -Y + DaXa(\theta) - DaSYa^k(\theta), \\ \theta' &= -\theta + DaBXa(\theta) - \beta(\theta - \theta_C) + DaB\alpha SYa^k(\theta), \end{aligned}$$

where

$$a(\theta) = \exp\left(\frac{\theta}{1 + \theta/\gamma}\right),$$

θ — dimensionless temperature, X and Y — dimensionless concentrations of components A and B .

Solve a system of equations for different values of Da from the interval $[0.2, 0.7]$ with the following initial data

$$\begin{aligned} x_0 &= 0.4, \quad y_0 = 0.5, \quad \theta_0 = 1.3, \quad k = 1, \quad \gamma = 20000, \\ \alpha &= S = 0.03, \quad \beta = 4, \quad \theta_C = 0, \quad B = 13. \end{aligned}$$

Plot the solution graphs.

Option 2.

A predator-prey system. Model Bazykina.

Let us consider the population dynamics of two predator-prey species interacting with each other in the presence of intraspecific competition of prey for limited resources and taking into account the factor of non-linearity of prey reproduction at low population densities. Denote by $x = x(t)$ and $y = y(t)$ the densities of prey and predator populations at time t . The equations take the following form:

$$\begin{aligned} x' &= \frac{ax^2}{N+x} \frac{K-x}{K} - bxy, \\ y' &= -cy + dxy, \end{aligned}$$

where a, b, c, d, N, K are non-negative numbers. By introducing dimensionless quantities

$$X = x/K, \quad Y = \left(\frac{b}{a}\right)y, \quad \tau = at, \quad n = \frac{N}{K}, \quad m = \frac{c}{dK}, \quad \gamma = \frac{dK}{a},$$

converting the equations to the form

$$\begin{aligned} X' &= \frac{(1-X)X^2}{n+X} - XY, \\ Y' &= \gamma(X-m)Y, \end{aligned}$$

For a number of values of the parameter m in the interval $[0.1, 0.35]$, solve the obtained system of equations with the following initial data

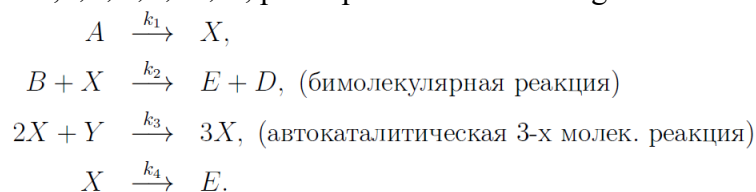
$$n = 0.1, \quad \gamma = 1, \quad X_0 = 0.3, \quad Y_0 = 0.3.$$

Plot the solution graphs.

Option 3.

Chemical reactions: brusselator.

Consider the model of Lefebvre and Nikolis (1971), the so-called "bruxelator": assume that six substances, A, B, D, E, X, Y , participate in the following reactions:



If we denote by $A(t), B(t), \dots$, the concentrations of substances A, B, \dots as functions of time t , then the reactions, according to the law of effective masses, are described by the following differential equations, assuming that B is added to the mixture at a constant rate α :

$$\begin{aligned} A' &= -k_1 A, \\ B' &= -k_2 B X + \alpha, \\ D' &= k_2 B X, \\ E' &= k_4 X, \\ X' &= k_1 A - k_2 B X + k_3 X^2 Y - k_4 X, \\ Y' &= k_2 B X - k_3 X^2 Y. \end{aligned}$$

Now we simplify this system: we exclude the equations for D and E from consideration, since they do not affect the rest; we also assume that A is maintained constant ($A = 1$) and take all reaction rates k_{ki} equal to unity. Next, we introduce the notation $y_1 = X, y_2 = Y, y_3 = B$ and as a result we get the system:

$$\begin{aligned} y_1' &= 1 + y_1^2 y_2 - (y_3 + 1) y_1, \\ y_2' &= y_1 y_3 - y_1^2 y_2, \\ y_3' &= -y_1 y_3 + \alpha, \end{aligned}$$

which depends only on one parameter α . The equations are supplemented with initial conditions

$$y_1(0) = 1, \quad y_2(0) = 1 + \alpha, \quad y_3(0) = 1 + \alpha.$$

For a number of values of the parameter α , solve the resulting system of equations and show that the solution is stable if $\alpha < (9 - \sqrt{17})/4 = 1.21922\dots$. If α is greater than this value, a limit cycle appears, which exists up to values of α approximately equal to 1.5. If α continues to grow, the limit cycle "explodes" and $y_1 \rightarrow 0, y_2, y_3 \rightarrow \infty$ at $t \rightarrow \infty$.

Plot the solution graphs.

Option 4.

A predator-prey system. The MacArthur model.

Let us consider the population dynamics of two predator-prey species interacting with each other in the presence of intraspecific competition of prey for limited resources and taking into account the factor of non-linearity of prey reproduction at low population densities. Denote by $x = x(t)$ and $y = y(t)$ the densities of prey and predator populations at time t . The equations take the following form:

$$\begin{aligned} x' &= a(1 - x/K)x - \frac{bxy}{1 + Ax}, \\ y' &= -cy + \frac{d}{1 + Ax}xy, \end{aligned}$$

where a, b, c, d, A, K are non-negative numbers. By introducing dimensionless quantities

$$X = \left(\frac{d}{c}\right)x, \quad Y = \left(\frac{b}{a}\right)y, \quad \tau = at, \quad \alpha = \frac{Ac}{d}, \quad \varepsilon = \frac{c}{Kd}, \quad \gamma = \frac{c}{a},$$

converting the equations to the form

$$\begin{aligned} X' &= (1 - \varepsilon X)X - \frac{XY}{1 + \alpha X}, \\ Y' &= \gamma \left(\frac{X}{1 + \alpha X} - 1\right)Y, \end{aligned}$$

For a number of values of the parameter α from the interval $[0.1, 0.9]$, solve the obtained system of equations with the following initial data

$$\varepsilon = 0.1, \quad \gamma = 1, \quad X_0 = 3, \quad Y_0 = 1.$$

Plot the solution graphs.

Option 5.

A predator-prey system. The Holling-Turner model.

Let us consider the population dynamics of two predator-prey species interacting with each other in the presence of intraspecific competition of prey for limited resources and taking into account the factor of non-linearity of prey reproduction at low population densities. Denote by $x = x(t)$ and $y = y(t)$ the densities of prey and predator populations at time t . The equations take the following form:

$$\begin{aligned}x' &= r(1 - x/K)x - \frac{wxy}{D + x}, \\y' &= s(1 - J\frac{y}{x})y,\end{aligned}$$

where r, s, w, K, D, J are non-negative numbers. By introducing dimensionless quantities

$$X = x/K, Y = \left(\frac{J}{K}\right)y, \tau = st, \alpha = \frac{w}{Js}, \beta = \frac{D}{K}, \gamma = \frac{r}{s},$$

converting the equations to the form

$$\begin{aligned}X' &= \gamma(1 - X)X - \frac{\alpha XY}{\beta + X}, \\Y' &= (1 - \frac{Y}{X})Y,\end{aligned}$$

For a number of values of the parameter α from the interval $[1, 30]$, solve the obtained system of equations with the following initial data

$$\beta = 0.13, \gamma = 5, X_0 = 0.5, Y_0 = 0.5.$$

Plot the solution graphs.

Lab #11: "pandas librariespandas, SciPy.stats. Descriptive statistics."

For a given sample, determine the numerical characteristics (sample mean, biased and unbiased variance, standard deviation, skewness and kurtosis coefficients), plot the sample distribution function and frequency histogram, taking the number of intervals equal to 8; assuming the data distribution is normal, construct a 95% confidence interval for the mathematical expectation of the general population.

Options 1-10. Based on the results of mechanical tests of a batch of steel samples, the values of the ultimate strength (in MPa) are obtained): 854, 903, 872, 892*, 933**, 881, 919, 903, 868, 932, 904, 865, 897, 868*, 905, 943**, 901, 868*, 947**, 908, 895, 853, 893, 878, 862, 857, 928, 919*, 925, 901, 911, 883*, 947**, 945, 881, 884, 939, 891, 885, 902, 938, 864*, 904, 895, 872, 896*, 878, 913, 875, 894, 878, 935, 878, 918, 891, 873*. (To the values marked with*, add $3N$, where N is the sequence number of the student in the group (option); to the values marked with**, add V , where V is the sequence number of the group in the stream).

Options 11-20. The wear of the cutting tool after a certain time of processing the part on the machine was (in microns): 54**, 103*, 72, 92, 83, 81, 79, 53**, 68, 82, 94, 65, 97, 110*, 78, 82, 63, 101*, 68, 87, 98, 95, 53**, 93, 78, 62, 57, 88, 99, 105*, 66, 73, 67, 101*, 91, 83, 57, 55**, 81, 83, 89, 91, 85, 102, 88, 108*, 93, 58, 67, 104*, 78, 85, 78, 85, 78, 108, 86, 91, 93, 88, 75, 68, 94, 115*, 84, 101. (Subtract $2N$ from the values marked with*, where N is the sequence number student in the group (option); marked ** - add V , where V is the sequence number of the group in the stream).

Lab #12: "pandas librariespandas, SciPy.stats. Testing the hypothesis about the type of distribution."

Model a normally distributed population of 1000 elements with a mean of 12 and a standard deviation of 0.25. Create a random sample of 200 elements for this population. Using the chi-square test, we check whether the sample is actually made from a normally distributed population.

Lab #13: "pandas librariespandas, SciPy.stats. Дисперсионный анализ Variance analysis."

Variation 1-10. A sales manager in a supermarket chain wants to know whether the placement of billboards affects the sales volume of an item. For each of the three types of billboards, 6 stores located in the corresponding area were randomly selected. Monthly sales volumes (mln. rubles) are shown in the table.

Location of billboards		
1	2	3
8,1*	3,9	4,8
7,5	4,4	6,0*
5,8	2,8**	4,4**
6,6	3,4	5,8
5,9	4,8*	6,2*
4,8**	3,6	4,9

(Subtract 0.1 N from the values marked with *, where N is the student's sequence number in the group (option); add V to the values marked with **, where V is the group's sequence number in flow 3).

Options 11-20. A company that produces sporting goods wants to compare the distance that balls made using 4 different technologies fly. According to each technology, 10 balls were produced. The balls were sent for testing to a sports club, where they were tested for a short period of time under the same weather conditions. Test results in Moscow:

Technology			
1	2	3	4
206**	203**	217	213
226*	223	230	231
208	206	221	221
224*	223	227	222
206	205	218	229
229*	234*	231*	235*
204	204	224	213
228*	219	225	228
209	210	211**	214
221	233	229	225

(Subtract N from the values marked with *, where N is the sequence number of the student in the group (option); add V to the values marked with **, where V is the sequence number of the group in the stream).

Lab #14: "pandas libraries pandas, SciPy.stats. Correlation analysis."

For a given sample, you can use a linear or parabolic pair regression model. Build both models and determine which one best approximates the experimental data. Use the coefficient of determination as a criterion for the quality of the model. On the scatter plot, show the lines corresponding to the constructed models.

Options 1-10. Establish the relationship between the maximum bending stress in the gear wheel x (MPa) and the number of cycles y (thousand cycles) before failure:

x	900	850	800	750	700	650	600	550	500	450	400
y	62**	64**	70	81	94	111	120	212	347*	542*	1230*

(From the values marked with *, subtract $10N$, where N is the sequence number of the student in the group (option); marked with * * - add V, where V is the sequence number of the group in the stream).

Options 11-20. Each of the 9 sales managers has a specific territory assigned to them. The table shows the population of this territory x in thousands of people and sales volumes provided by the corresponding manager, y in millions of rubles.

x	4,96	8,26	9,09	12,25*	4,73	13,68*	3,58	2,77**	4,64
y	2,69**	3,54	3,32	3,54	2,25	5,15	2,02	1,71	3,26

(Subtract 0.1 N from the values marked with *, where N is the sequence number of the student in the group (option); add 0.04V to the values marked with **, where V is the sequence number of the group in the stream).

Lab #15: "pandas librariespandas, SciPy.stats. Regression analysis."

Perform multiple regression analysis of the model for a given sample

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3.$$

Options 1-10. A table of experimental data on the dependence of the productivity of the production of bearing rings (thousand units) on the content of mechanical impurities x_1 (m^2/l), soda x_2 (g/l) and sodium nitrate x_3 (g/l) in the cooling lubricant used in the process of grinding rings is given.

x_1	309	220	90**	100	156	110
x_2	1,8*	4,0	5,6	5,1*	7,5	6,9
x_3	1,8	4,0*	5,6*	5,1	6,6	7,6
y	61	54	65	53	56	54
x_1	140	200	135	46**	40**	32**
x_2	6.5	6.4	6.7	6.9	8.5	7.5
x_3	8,0	9,2	8,3*	1,5*	1,9*	2,0
y	57	70	82	57	51	68

(From the values marked with*, subtract $0.1N$, where N is the sequence number of the student in the group (option); marked with ** - add $10V$, where V is the sequence number of the group in the stream).

Options 11-20. The dependence of the yield of grain crops y on the number of tractors used x_1 , combine harvesters x_2 and fertilizer consumption x_3 is analyzed. Data on 18 farms are provided.

x_1	16	4	25	48*	21	21	7	4	5
x_2	25	27	29	39	26	30	28	26	24
x_3	3,1**	58	3,2	4,2	3,9	3,3	4,2	2,3	2,0**
y	98	85	91	99	97	87	125*	77	70
x_1	33	14	24	93*	17	6	3	15*	1
x_2	32	31	32	41	27	29	25	29	20
x_3	12,2	7,2	2,6	4,1	8,5	1,2	0,9**	2,1	4,2
y	140*	98	109	119*	98	71	73	84	84

(From the values marked with*, subtract $0,1N$, where N is the sequence number of the student in the group (option); marked with ** - add V , where V is the sequence number of the group in the stream).

Lab #16: "Neural networks. Programming an artificial neuron."

Develop a program that simulates the behavior of an artificial three-input neuron and provides its training for solving the classification problem. Below is a table of task options.

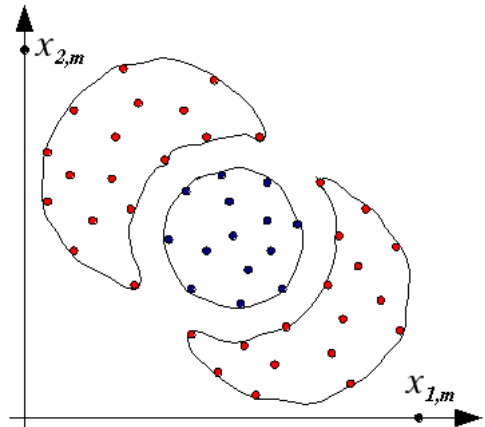
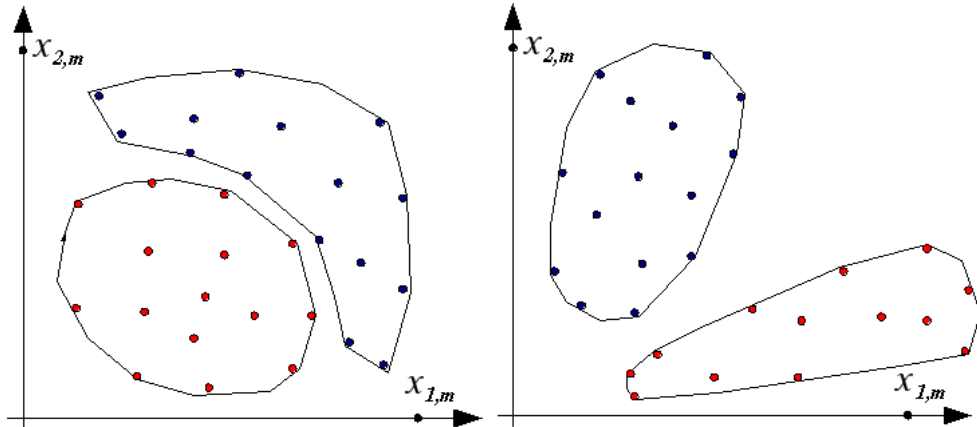
Option number	Neuron type
1	Perceptron
2	Sigmoid neuron
3	Radial neuron
4	Grossberg Instar
5	WTA Neurons

Debug the neuron model and its training procedure on arbitrary two-dimensional data. It is recommended that you use the "offline" learning mode whenever possible.

Train the developed neuron on the two-dimensional data option proposed by the teacher and check its performance at a number of control points. Options for different training samples are given below (scaling values $x_{x1, m}$ and $x_{x2, m}$ must be requested from the teacher).

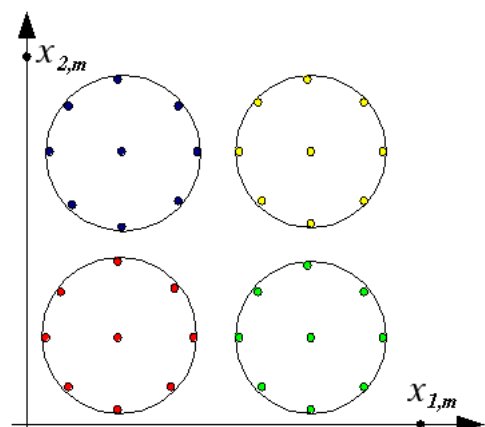
Option 1 of training data

Option 2 of the training data



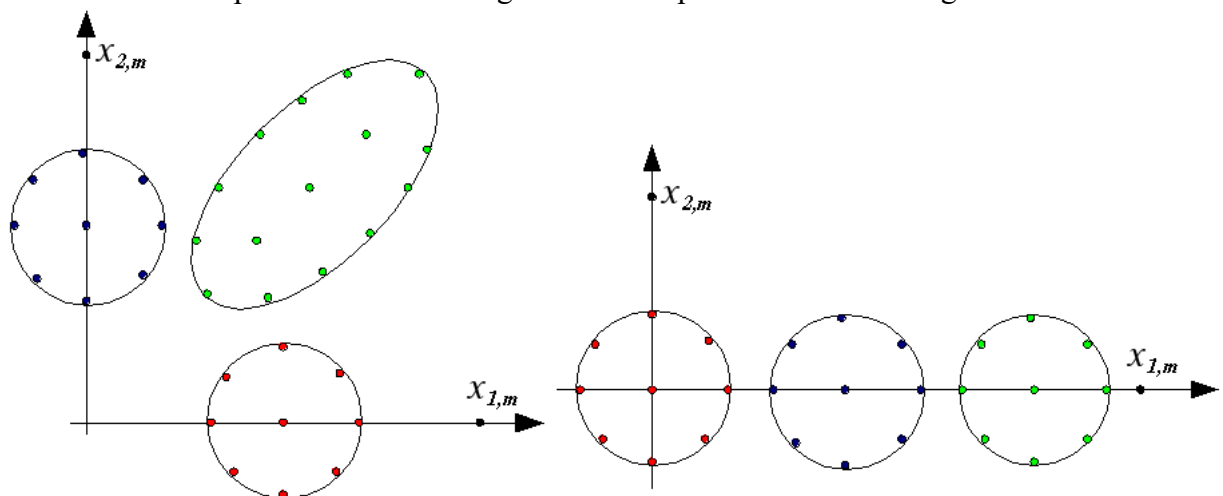
Option 3 of the training data

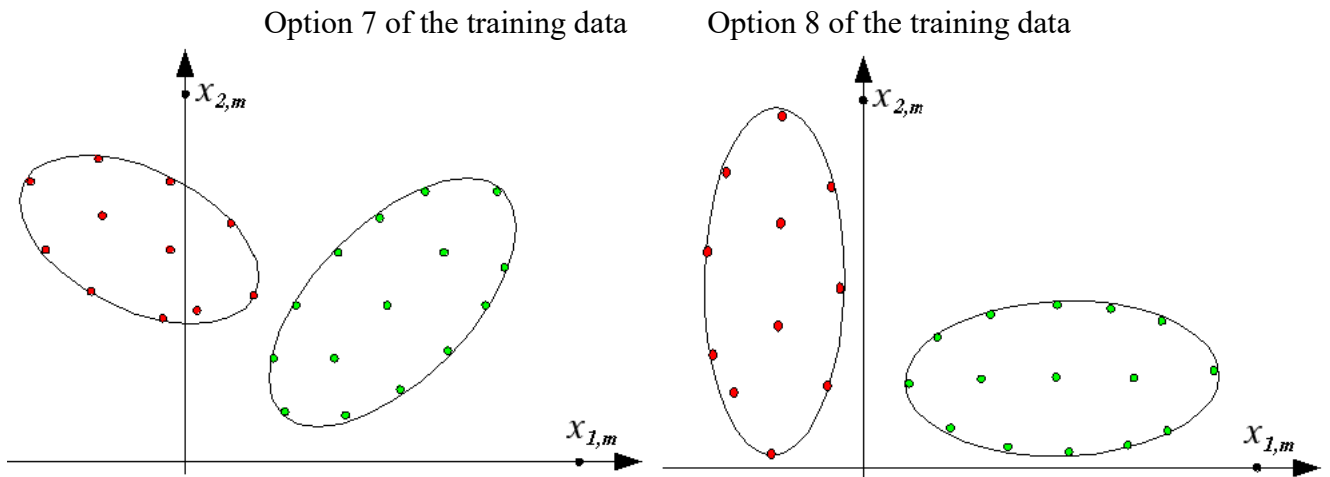
Option 4 of the training data



Option 5 of the training data

Option 6 of the training data





Lab #17: "Neural networks. Библиотеки Keras, TensorFlow , or Theano libraries. Programming an artificial neuron."

Upgrade the program written in lab # 16 using the Keras, TensorFlow , or Theano libraries. For the upgraded program, complete the task of laboratory work No. 16. Compare the results.

Lab #18: "Neural networks. Programming an artificial neural network. Part 1."

Develop a program that simulates the behavior of an artificial neural network and provides its training for solving problems of lossy data compression, classification, and approximation. Below is a table of task options.

Option number	Type of neural network	Network assignment
1	Two-layer network with linear activation functions	Image compression
2	A network with self-organization based on competition	Image compression
3	A network with self-organization based on competition	Classification of data by Kohonen's algorithm
4	A network with self-organization based on competition	Classification of data using the neural gas algorithm
5	Multi-layer perceptron (binary activation functions)	Data approximation
6	Multi-layer perceptron (sigmoid activation functions)	Data approximation
7	Radial neural network	Data approximation

Debug the neural network model and perform its training procedure on arbitrary data. For tasks related to image processing, you must prepare [gimp](#) several grayscale images (8 - bit depth) in png format with sizes that are multiples of 16 using any bitmap graphics editor (for example, gimp). For debugging classification tasks, you can use the data distribution options from Lab # 16.

Lab #19: "Neural networks. Programming an artificial neural network. Part 2."

Train the neural network developed in laboratory work No. 18 on the proposed version of the data and check its performance.

Option number	Data
1	<p>Program an artificial neural network that provides classification of iris plant varieties (Iris Setosa-0, Iris Versicolour-1, Iris Virginica-2) by the four sizes of pistils and stamens of its flowers. File iris.dat.gz it contains 50 examples of each class. Use the first 100 entries for training, and the last 50 for testing. File iris_CR.dat.gz contains a normalized version of the same data.</p>
2	<p>Program an artificial neural network that provides classification of parts of the earth's surface based on their " images " from space. Each image has a size of 3x3 "pixels", each pixel is characterized by four values (4 different spectral ranges). There are 7 types of soil:</p> <ol style="list-style-type: none"> 1. - clay (red) soil; 2. - industrial crops (cotton); 3. - gray soil; 4. - moistened gray soil; 5. - mowing (stubble); 6. - a mixture of all these coatings (there are no examples); 7. - very wet gray soil. <p>File satimage.dat.gz it contains 6435 records. Use the first 5000 records for training, and the rest for testing. File satimage_CR.dat.gz contains a normalized version of the same data.</p>
3	<p>Training a multi-layer perceptron to play 3x3 tic-tac-toe. The cells are indexed from 1 to 9. The input is a nine-element vector, in which the corresponding position is set to 0 if it contains 0, 1 if x, and 0.5 if the cell is empty. At the output, you must have a new position after the neural network moves (the neural network learns to play with zeros). They start making crosses.</p> <p>Example.</p> <pre> Input position.... X. ... Input code 0.5 0.5 0.5 0.5 1.0 0.5 0.5 0.5 0.5 0.5 Neural network response 0.5 0.5 0.5 0.5 1.0 0.0 0.5 0.5 0.5 Position after the neural network moveXO ... </pre> <p>Hint. Play a few rough games with yourself, writing down the sequence of moves. Train the neural network by setting all the answer moves in zeros. Next, try to play with the neural network. If it returns an incorrect (or impossible) answer, make a move for it and include this example in the training sample, then continue training.</p>
4	<p>Classification of glass types by their physical and chemical properties in forensic investigation practice. Glass fragments are characterized by the following nine parameters:</p> <ol style="list-style-type: none"> 1. refractive 2. index; weight fraction of sodium oxide(oxides) 3. ; 4. weight fraction of manganese oxide(oxides); weight fraction of aluminum oxide(oxides); 5. weight fraction of silicon oxide(oxides); 6. weight fraction of potassium oxide(oxides); 7. weight fraction of calcium oxide (oxides); 8. weight fraction of barium oxide (oxides);

9. weight fraction of iron oxide (oxides).

It is necessary to distinguish between seven types of glass:

1. window glass of the 1st type;
2. window glass of the 2nd type;
3. automobile glass
4. ;
5. glass vessels;
6. table glass;
7. car headlight glass.

In the file glass.data.gz data is stored for 214 glass samples. Use the first 180 examples for training, and the rest for testing.

Laboratory work #20: "Neural networks. Библиотеки Keras, TensorFlow , or Theano libraries. Programming andskus of an artificial neural network."

Upgrade the program written in lab # 18 using the Keras, TensorFlow , or Theano libraries. For the upgraded program, complete the task of laboratory work No. 19. Compare the results.

Evaluation criteria (in points):

- **9-10 баллpoints** are awarded to a student if the student has given complete, detailed answers to all theoretical questions, demonstrated knowledge of functional capabilities, terminology, basic elements, and the ability to apply theoretical knowledge in performing practical tasks. The student easily answered all the additional questions. The practical part of the work was completed completely without any inaccuracies or errors.

- **7-8 gradea** is awarded to the student if the student has covered mainly theoretical questions, but there are inaccuracies in the definition of basic concepts. Some minor inaccuracies were made when answering additional questions. Minor mistakes were made when performing the practical part of the work.

- **4-6 points** are awarded to the student if the student makes several significant errors in the interpretation of basic concepts when answering theoretical questions. The logic and completeness of the answer suffer from noticeable flaws. There are noticeable gaps in knowledge of the main methods. Theoretical questions are generally presented sufficiently, but with omissions of material. There are fundamental errors in the logic of constructing the answer to the question. The student did not solve the problem or made some serious mistakes.

- **1-3 gradea** is awarded to the student if the answer to theoretical questions indicates a lack of understanding and extremely incomplete knowledge of basic concepts and methods. There is a lack of skills in applying theoretical knowledge in performing practical tasks. The student could not answer any additional questions.

5. Educational, methodical and informational support of the discipline

5.1. List of basic and additional educational literature required for mastering the discipline

Main literature:

1. Summerfield, M. *Python in practice*-Moscow: DMK Press PublishingHouse, 2014 — Access to the text of the electronic edition is possible through the Lan Electronic Library System —
<https://e.lanbook.com/book/66480>.
2. Luciano Ramaglio, *Python. To the heights of mastery*-Moscow: DMK Press Publishing House, 2016, Access to the text of an electronic publication is possible through the Lan Electronic Library System —
<https://e.lanbook.com/book/93273>
3. Ues, M. *Python and Data Analysis*-Moscow: DMK Press, 2015. Access to the text of the electronic edition is possible through the Lan Electronic Library System —
<https://e.lanbook.com/book/73074>
4. Coelho, L. P. *Building machine Learning systems in Python*— Moscow: DMK Press, 2016. Access to the text of the electronic edition is possible through the Lan Electronic Library System —
<https://e.lanbook.com/book/82818>.

Additional literature:

5. M. Dawson, *Programming in Python* — Saint Petersburg: St. Petersburg, 2016.
6. Tsch. Severens. *Introduction to Python Programming -KNOW INTUIT, 2016*, Access to the text of the electronic edition is possible through the Lan Electronic Library System —
<https://e.lanbook.com/book/100703>
7. I. A.Khakhaev, *Workshop on Algorithmization and programming in Python-KNOW INTUIT, 2016*, Access to the text of the electronic edition is possible through the Lan Electronic Library System —
<https://e.lanbook.com/book/100377>
8. Rashka, S. *Python and Machine Learning: A Much-needed Guide to the Latest Predictive Analytics, Essential for a Deeper Understanding of machine learning Methodology*-Moscow: DMK Press, 2017 Access to the text of the electronic edition is possible through the Lan Electronic Library System —
<https://e.lanbook.com/book/100905>.
9. P. Shabanov, Научная графика в Python,
https://github.com/whitehorn/Scientific_graphics_in_python,
http://nbviewer.jupyter.org/github/whitehorn/Scientific_graphics_in_python/blob/master/P1%20Chapter%201%20Pyplot.ipynb
10. SciPy Manual, <https://docs.scipy.org/doc/scipy/reference/index.html>, partial translation - http://san-tit.blogspot.com/p/blog-page_3.html:
http://san-tit.blogspot.com/p/blog-page_3.html.

5.2. List of Internet information and telecommunications network resources and software required for mastering the discipline, including professional databases and information reference systems

- Open educational video portal UniverTV.ru Educational films on various topics. Lectures at leading Russian and foreign universities. A scientific conference or popular science lecture on a topic that interests you. <http://univertv.ru/video/matematika/>
- All-Russian mathematical portal. <http://www.mathnet.ru>
- EBS "University Library Online";
- EBS of Lan Publishing House;
- EBS "Electronic reading room";
- Information system "Single window of access to educational resources" (<http://window.edu.ru>);
- <https://simpy.readthedocs.io/en/latest/>
- <https://matplotlib.org/contents.html>
- <https://scipy.org/>
- <http://scipy-tutorial.ru/>
- <https://keras.io/>
- <https://www.tensorflow.org/>
- <http://deeplearning.net/software/theano/>
- <https://github.com/Theano/>
- Windows 8 Russian. Windows Professional 8 Russian Upgrade. Agreement No. 104 of 17.06.2013.Licenses are perpetual.
- Microsoft Office Standard 2013 Russian. Agreement No. 114 of 12.11.2014.Licenses are perpetual.
- Python 3.7 (Python SoftwareFoundationLicense, cfree software)
- Simply Linux x86_64 (license agreement for the Simply Linux 8.2.0 software and the included computer programs, free software)

6. Material and technical base necessary for the implementation of the educational process in the discipline

Name of special premises and premises for independent work	Equipment of special rooms and rooms for independent work	List of licensed software. Details of the supporting document
<i>1</i>	<i>2</i>	<i>3</i>
<p>1. training room for conducting seminar-type classes: auditorium No. 520a (fizmat building - educational), No. 521 (fizmat building - educational), auditorium No. 522 (fizmat building - educational), auditorium No. 524 (fizmat building - educational), auditorium No. 525 (fizmat building - educational)</p> <p>2. training room for group and individual consultations: auditorium No. 520a (fizmat building - educational), No. 521 (fizmat building - educational), auditorium No.</p>	<p>Audience #426 Educational furniture, whiteboard, personal computers LenovoThinkCentreA70zIntelPentiumE 5800, 320 Gb, 19" - 13 pcs., cabinet TLKTWP-065442-G-GY</p> <p>Auditorium #520a Educational furniture, blackboard, monitor LG 19 L1942S SF 1280 x 1024.5 ms, 8000:1, black (3.4 kg, VGA, 19"(48.3 cm) 5mc, monitors LG 19 " L1942SBF 1280x1024.5ms, 8000:1,black 10 pcs, system unit HPPavilionSlimlineS3500FAMDathlon64 X2 5400+/2.8GHz, 4Gb, 500Gb 12pcs, auditor board. YES36.</p> <p>Audience # 521</p>	<p>. 1. Windows 8 English. Windows Professional 8 Russian Upgrade. Agreement No. 104 of 17.06.2013.Licenses are perpetual.</p> <p>2. Microsoft Office Standard 2013 Russian. Agreement No. 114 of 12.11.2014.Licenses are perpetual.</p> <p>3. Python 3.7 (Python license SoftwareFoundationLicense, cfree software)</p> <p>4. Simply Linux x86_64 (license agreement for the software Simply Linux 8.2.0 and the included computer programs, free software)</p>

<p>522 (fizmat building - educational), auditorium No. 524 (fizmat building - educational), auditorium No. 525 (fizmat building - educational)</p> <p>3. classroom for current monitoring and interim assessment: auditorium No. 520a (fizmat building - educational), No. 521 (fizmat building - educational), auditorium No. 522 (fizmat building - educational), auditorium No. 524 (fizmat building - educational), auditorium No. 525 (fizmat building - educational)</p> <p>4. rooms for independent work: auditorium No. 426 (fizmat building-educational), reading room No. 2 (fizmat building - educational)</p> <p>5. premises for storage and preventive maintenance of educational equipment: auditorium No. 522 (fizmat building - uchebnoe)</p>	<p>Educational furniture, whiteboard, Switchboard HP V1905-24 Switch 24*10/100+2*10/100/1000, personal computers included DEPO Neos 460MDi5 2300/4GDDR1333 /T500G/DVD W-12 pcs., projector Optoma EX542i.DLP3D..XGA(1024*768).2700 ANSI Lm.3000 1.Lamp5000+ / -40 ver, TLKTWP-065442-G-GY cabinet, Draper Diplomat tripod screen (1:1) 84/84* 213*213 MW, board auditor. YES36.</p> <p>Audience #522</p> <p>Educational furniture, whiteboard, personal computer LenovoThinkCentre A70z IntelPentium E 5800, 320 Gb, 19" - 13 pcs., air conditioning LessarLS/LU-H24KB2.</p> <p>Audience # 524</p> <p>Educational furniture, chalkboard, HP V1905-24 Switch 24*10/100+2*10/100/1000, personal computer included HP AiO 20 "CQ 100 eu-27 pcs., ScreeMediaGolgvieScreenMediaGolgview 274*206 NW 4:3 screen, ScreeMedia universal ceiling mount ScreeMediafor projector, height adjustment, cabinet TLKTWP-065442-G-GY, patch cord (1296), auditor board. YES32.</p> <p>Audience # 525</p> <p>Educational furniture, whiteboard, personal computers included DEPO Neos 460MDi5 2300/4GDDR1333 /T500G/DVDW/ - 13 pcs., whiteboard auditor. YES32.</p> <p>Reading room No. 2</p> <p>Educational furniture, educational and visual aids, fire safety stand, stationary monoblocks-8 pcs., printer-1 pc., scanner-1 pc</p>	
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ФГБОУ ВО BASHKIR STATE UNIVERSITY

FACULTY OF MATHEMATICS AND INFORMATION TECHNOLOGY

CONTENT OF THE WORK PROGRAMdisciplines Coding Practicum for 5,6,7,8 5,6,7,8 semester
(name of the discipline)--- full-time ---
form of training

Type of work	Scope of the discipline
Total labor intensity of the discipline (Z / hours)	4 / 144
Training hours for contact work with the teacher:	128.8,8
lectures	
of practical / seminar	
laboratory	128
others (group, individual consultation and other types of educational activities that involve students working with a teacher) (FCR)	0.8,8
Training hours for independent work of students (SR)	15,2
Training hours to prepare for the exam/test/differentiated test (Control)	

Control form(s) :

exam _____ semester

credit 5,6,7,8 semester

№ n/a num ber	Subject and content	Form of studying materials: lectures, practical classes, seminars, laboratory work, independent work and labor intensity (in hours)				Basic and additional literature recommended to students (numbers from the list)	Tasks for students 'independent work	Form of current performance monitoring (colloquiums, test papers, computer tests, etc.)
		LK	PR / SEM	LR	SRS			
1	2	3	4	5	6	7	8	9
<i>5thsemester</i>								
1.	Язык программирования The Python programming language. Language syntax, built-in data types.			6		[1-2]	[5-7]	Laboratory work
2.	A conditional statement in Python.			6		[1-2]	[5-7]	
3.	Loops in Python.			6		[1-2]	[5-7]	Laboratory work
4.	Lists, tuples, and dictionaries.			6		[1-2]	[5-7]	
5.	Functions in Python. NumPy Library.			6		[1-2]	[5-7]	
6.	Repetition, preparation for the test.			2	3.8	[1-2]	[5-7]	
	Total for the 5th semester			32	3.8			
<i>6thsemester</i>								
1.	Working with files in Python.			4		[1-2]	[5-7]	Laboratory work
2.	The SymPy library. Differentiation, integration, and calculation of limits. Solving ordinary differential equations.			4		[1-3]	[5-7], [10]	
3.	Scientific graphics in Python. The matplotlib library. Pyplot. Basic graphical commands			6		[1-3]	[5-7], [9]	Laboratory work
4.	Scientific graphics in Python. The matplotlib library.			8		[1-3]	[5-7], [9]	

	Pyplot. Plotting functions in different coordinate systems.							
5.	The SciPy.integrate library. Numerical integration. Numerical solution of the ODE.			8		[1-3]	[5-7], [9-10]	
6.	Repetition, preparation for the test			2	3,8,8	[1-3]	[5-7], [9-10]	
	Total forthe 6th semester			32	3.8,8			
<i>7thsemester</i>								
1.	Libraries pandas, SciPy.stats. Descriptive statistics.			6		[3-4]	[5-7]	Laboratory work
2.	The pandas and SciPy. stats libraries. Testing a hypothesis about the type of distribution.			6		[3-4]	[5-7]	
3.	Libraries pandas, SciPy.stats. Analysis of variance.			6		[3-4]	[5-7]	Lab work
4.	pandas and SciPy. stats libraries. Correlation analysis.			6		[3-4]	[5-7]	
5.	Libraries pandas, SciPy. stats. Regression analysis.			6		[3-4]	[5-7]	
6.	Repetition, test preparation			2	3.8.8	[3-4]	[5-7]	
	Total forthe 7th semester			32	3.8			
<i>8thsemester</i>								
1.	Neural networks. Programming an artificial neuron.			6		[3-4]	[8]	Laboratory work
2.	Neural networks. Keras, TensorFlow, or Theano libraries. Programming an artificial neuron.			6		[3-4]	[8]	
3.	Neural networks. Programming an artificial neural network. Part 1.6			6		[3-4]	[8]	Laboratory work

4.	Neural networks. Programming an artificial neural network. Part 2.6			6		[3-4]	[8]	
5.	Neural networks. Keras, TensorFlow, or Theano libraries. Programming an artificial neural network.			6		[3-4]	[8]	
6.	Repetition, test preparation			2	3.8.8	[3-4]	[8]	
	Total forthe 8th semester			32	3.8			
	Total hours:			128	15,2			