APPROVED
Vice Rector for Academic Affairs

A.A. Voronov

Work program of the course (training module)

course:	Foundations of Programming II/Основы программирования II
major:	Biotechnology
specialization:	Biomedical Engineering/Биомедицинская инженерия
	Phystech School of Biological and Medical Physics
	Chair of Informatics and Computational Mathematics
term:	1
qualification:	Bachelor

Semester, form of interim assessment: 2 (spring) - Grading test

Academic hours: 60 AH in total, including:
     lectures: 0 AH.
     seminars: 0 AH.
     laboratory practical: 60 AH.

Independent work: 120 AH.

In total: 180 AH, credits in total: 4

Number of course papers, tasks: 4

Author of the program: T.F. Khiryanov, senior professor

The program was discussed at the Chair of Informatics and Computational Mathematics 27.04.2022

Annotation

This course provides basic knowledge to get started with Python programming.

It explores ways to store tabular data, process it, and visualize results.

The course also includes the study of programming paradigms: modular, functional and object-oriented.

The creation of programs is accompanied by the study of the git version control system and methods of automatic software testing.

1. Study objective

Purpose of the course

   - to give learners knowlege and experience of using Python programming language for solving numerical calculations tasks.

Tasks of the course

   - statement of the basic principles of programming, their main applications in modern programming;

   - providing the student with guidelines for further independent study of individual issues in specialized sections of mathematical logic and programming.

2. List of the planned results of the course (training module), correlated with the planned results of the mastering the educational program

Mastering the discipline is aimed at the formation of the following competencies:

Code and the name of the competence	Competency indicators
Gen.Pro.C-1 Apply knowledge of mathematical, physical, chemical, biological laws, patterns, and interrelation to study, analyze, and utilize biological objects and processes	Gen.Pro.C-1.1 Analyze the task in hand, outline the ways to complete it
Gen.Pro.C-2 Use modern IT and software tools to perform professional tasks in compliance with information security requirements	Gen.Pro.C-2.1 Apply modern computing tools and Internet services in professional settings

3. List of the planned results of the course (training module)

As a result of studying the course the student should:

know:

   - the role of programming in solving scientific problems;
   - basic algorithms with their asymptotic complexity;
   - simple part of Python language syntax.

be able to:

   - develop software applications for solving tasks in a programming language;
   - develop algorithms for solving programming problems.

master:

   - to install development environment of Python;
   - to use the set of programming tools for Python language;
   - skill of coding given algorith on Python language;
   - skills in the basics of object-oriented programming.

4. Content of the course (training module), structured by topics (sections), indicating the number of allocated academic hours and types of training sessions

4.1. The sections of the course (training module) and the complexity of the types of training sessions

№	Topic (section) of the course	Types of training sessions, including independent work			
		Lectures	Seminars	Laboratory	Independent

		Lectures	Seminars	practical	work
1	Python standard data containers.			12	20
2	Working with tabular data.			12	25
3	Overview of data visualization libraries.			12	25
4	Practical techniques for work on the software product			12	25
5	Object-oriented and functional programming			12	25
AH in total				60	120

Exam preparation	0 AH.
Total complexity	180 AH., credits in total 4

4.2. Content of the course (training module), structured by topics (sections)

Semester: 2 (Spring)

1. Python standard data containers.

Work with text.
  Symbol code, encoding and text transpoding
  Sections of string
  Search in a string with standard Python tools.
  Regular expressions
Lists, arrays, cortices, named cortices.
  Slices of lists and assignment in them.
  Standard lists methods.
  Sort by key.
  Massives with a fixed data type.
  NamedTuple container from the Collections library.
  Tasks for the use of lists and tuples.
Sets and dictionaries
  Frequency analysis with a dictionary.
  Collections library.

2. Working with tabular data.

Numpy library arrays
Tabular data in Pandas.

3. Overview of data visualization libraries.

Building graphs and charts in MATPLOTLIB.
Seaborn library.
NetworkX library.
  Graphs and trees.
  Storage of the graph in the memory of the computer.

4. Practical techniques for work on the software product

Git version control system.
Design of software product.
Automatic testing of programs.

5. Object-oriented and functional programming

Functional programming.
    Function as an object of the first kind. Unnamed lambda functions.
    Deferred calculations. Generators as a convey.
    Decorators. Modification of the behavior of functions.
Objects and classes.
    Constructor. Special methods.
    Functors.
Generation and exception processing.
    Standard hierarchy of exception classes.
    Creating your exceptions.
    Context manager with.

5. Description of the material and technical facilities that are necessary for the implementation of the educational process of the course (training module)

- a projector with the ability to connect via HDMI and / or VGA);
- blackboard with chalk or whiteboard with felt-tip pens;
- computer class equipped with a PC.

6. List of the main and additional literature, that is necessary for the course (training module) mastering

Main literature
1. Introduction to Machine Learning with Python. A Guide for Data Scientists /Andreas C. Muller, Sarah Guido. Beiling ; Boston, O'REILLY, 2017
2. Hands-on data structures and algorithms with Python, Write complex and powerful code using the latest features of Python 3.7 /B. Agarwal, B. Baka. Birmingham ; Mumbai, Packt, 2018

Additional literature

7. List of web resources that are necessary for the course (training module) mastering

1. SimonPeytonJones (editor), Haskell 98 LanguageandLibraries (TheRevisedReport)
2. JohnHughes, IntroductiontoProgramminginHaskell, www.cs.chalmers.se/~rjmh
3. PaulHudak, JohnPeterson, Joseph H. Fasel ,A GentleIntroductiontoHaskell 98
4. CordeliaHall, JohnHugs, ThelittleHaskeller
5. PhilipWadler, Monadsforfunctionalprogramming, DepartmentofComputingScience, UniversityofGlasgow
6. AllAboutMonads , http://www.nomaware.com/monads/html/
7. EmeryBerger , FP + OOP = Haskell, DepartmentofComputerScience, TheUniversityofTexasatAustin
8. RexPage, TwoDozenShortLessonsinHaskell, a participatorytextbookonfunctionalprogramming, SchoolofComputerScience, UniversityofOklahoma
9. DamirMedak, GerhardNavratil, Haskell-Tutorial, InstituteforGeoinformationTechnicalUniversityVienna
10. Главная страница языка Haskell, http://haskell.org.

Литератра
1. Object oriented programming with C++, 4 edition - E. Balagurusamy, 2008 -учебник свободно доступен в сети интернет
2. C++:The Complete Reference, 4 edition - Herbert Schildt, 2003 - учебник свободно доступен в сети интернет

8. List of information technologies used for implementation of the educational process, including a list of software and information reference systems (if necessary)

The lecture classes use multimedia technology, including the presentation of presentations. Electronic books are used.

9. Guidelines for students to master the course

A student studying a discipline must, on the one hand, master the general conceptual apparatus, and on the other hand, must learn to put theoretical knowledge into practice.

As a result of studying the discipline, the student must know the basic definitions, concepts, axioms.

Successful development of the course requires intense independent work of the student. The course program provides the minimum necessary time for the student to work on the topic. Independent work includes:

• reading and taking notes of recommended literature;

• study of educational material (according to lecture notes, educational and scientific literature), preparation of answers to questions intended for independent study, proof of individual statements, properties;

• laboratory work to understand the connections between theory and practical skills;

• preparation for differentiated classification.

The management and control of the student's independent work is carried out in the form of individual consultations.

It is important to gain an understanding of the material being studied, and not its mechanical memorization. If it is difficult to study individual topics, questions, you should consult a lecturer.

Assessment funds for course (training module)

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term:	1
qualification:	Bachelor

Semester, form of interim assessment: 2 (spring) - Grading test

Author: T.F. Khiryanov, senior professor

1. Competencies formed during the process of studying the course

Code and the name of the competence	Competency indicators
Gen.Pro.C-1 Apply knowledge of mathematical, physical, chemical, biological laws, patterns, and interrelation to study, analyze, and utilize biological objects and processes	Gen.Pro.C-1.1 Analyze the task in hand, outline the ways to complete it
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2. Competency assessment indicators

As a result of studying the course the student should:

know:
- the role of programming in solving scientific problems;
- basic algorithms with their asymptotic complexity;
- simple part of Python language syntax.

be able to:
- develop software applications for solving tasks in a programming language;
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master:
- to install development environment of Python;
- to use the set of programming tools for Python language;
- skill of coding given algorith on Python language;
- skills in the basics of object-oriented programming.

3. List of typical control tasks used to evaluate knowledge and skills

Not provided

4. Evaluation criteria

1. Build systems and continuous integration.
2. Version control systems.
3. Introduction to Object-oriented programming.
4. Objects and classes. Encapsulation.
5. Inheritance and virtual functions.
6. Pure abstract functions and interfaces. Multiple inheritance.
7. Template functions and template classes.
8. Iterators: usage and implementation.
9. Standard Template Library design and implementation overview.
10. Algorithms on ranges.
11. String classes. One byte and wide char strings.
12. Exceptions and error handling. Input/Output classes.
13. Object lifetime management. Smart pointers.
14. Factory classes, factory methods and singletons.
15. Pointers to functions, function wrapping and binding.

Examination ticket:
1. Version control systems.
2. Pointers to functions, function wrapping and binding.

Assessment "excellent (10)" is given to a student who has displayed comprehensive, systematic and deep knowledge of the educational program material, has independently performed all the tasks stipulated by the program, has deeply studied the basic and additional literature recommended by the program, has been actively working in the classroom, and understands the basic scientific concepts on studied discipline, who showed creativity and scientific approach in understanding and presenting educational program material, whose answer is characterized by using rich and adequate terms, and by the consistent and logical presentation of the material;

Assessment "excellent (9)" is given to a student who has displayed comprehensive, systematic knowledge of the educational program material, has independently performed all the tasks provided by the program, has deeply mastered the basic literature and is familiar with the additional literature recommended by the program, has been actively working in the classroom, has shown the systematic nature of knowledge on discipline sufficient for further study, as well as the ability to amplify it on one's own, whose answer is distinguished by the accuracy of the terms used, and the presentation of the material in it is consistent and logical;

Assessment "excellent (8)" is given to a student who has displayed complete knowledge of the educational program material, does not allow significant inaccuracies in his answer, has independently performed all the tasks stipulated by the program, studied the basic literature recommended by the program, worked actively in the classroom, showed systematic character of his knowledge of the discipline, which is sufficient for further study, as well as the ability to amplify it on his own;

Assessment "good (7)" is given to a student who has displayed a sufficiently complete knowledge of the educational program material, does not allow significant inaccuracies in the answer, has independently performed all the tasks provided by the program, studied the basic literature recommended by the program, worked actively in the classroom, showed systematic character of his knowledge of the discipline, which is sufficient for further study, as well as the ability to amplify it on his own;

Assessment "good (6)" is given to a student who has displayed a sufficiently complete knowledge of the educational program material, does not allow significant inaccuracies in his answer, has independently carried out the main tasks stipulated by the program, studied the basic literature recommended by the program, showed systematic character of his knowledge of the discipline, which is sufficient for further study;

Assessment "good (5)" is given to a student who has displayed knowledge of the basic educational program material in the amount necessary for further study and future work in the profession, who while not being sufficiently active in the classroom, has nevertheless independently carried out the main tasks stipulated by the program, mastered the basic literature recommended by the program, made some errors in their implementation and in his answer during the test, but has the necessary knowledge for correcting these errors by himself;

Assessment "satisfactory (4)" is given to a student who has discovered knowledge of the basic educational program material in the amount necessary for further study and future work in the profession, who while not being sufficiently active in the classroom, has nevertheless independently carried out the main tasks stipulated by the program, learned the main literature but allowed some errors in their implementation and in his answer during the test, but has the necessary knowledge for correcting these errors under the guidance of a teacher;

Assessment "satisfactory (3)" is given to a student who has displayed knowledge of the basic educational program material in the amount necessary for further study and future work in the profession, not showed activity in the classroom, independently fulfilled the main tasks envisaged by the program, but allowed errors in their implementation and in the answer during the test, but possessing necessary knowledge for elimination under the guidance of the teacher of the most essential errors;

Assessment "unsatisfactory (2)" is given to a student who showed gaps in knowledge or lack of knowledge on a significant part of the basic educational program material, who has not performed independently the main tasks demanded by the program, made fundamental errors in the fulfillment of the tasks stipulated by the program, who is not able to continue his studies or start professional activities without additional training in the discipline in question;

Assessment "unsatisfactory (1)" is given to a student when there is no answer (refusal to answer), or when the submitted answer does not correspond at all to the essence of the questions contained in the task.

5. Methodological materials defining the procedures for the assessment of knowledge, skills, abilities and/or experience

The time for differentiated classification is 2 academic hours.
During the test, students can use the discipline program and source texts.