Course name	**Algorithms and Data Structures**
Course code	***DatZ2008***
Branch of science	Computer science
Sub-branch of science	Algorithms and data structures
Credit points	4
ECTS credit points	6
Total contact hours	**64**
2nd semester: *Number of hours for lectures* *Number of hours for seminars and practical work*	 16 16
3rd semester: *Number of hours for lectures* *Number of hours for seminars and practical work*	 16 16

Prerequisite knowledge
2nd semester: DatZ1049, Programming Foundation (C++) I[IT, 1.sem] **3rd semester:** DatZ1037, Algorithms and data structures I [IT, Ik, 2sem] DatZ1049, Programming Foundation (C++) I[IT, 1sem] DatZ1057, Programming Foundation (C++) II [IT, Ik, 2sem]

Course abstract:
The course is intended for students of professional bachelor program "Information Technologies" (42481). The aim of this course is to give an introduction to the basic types and data structures to be used in programming, algorithm design and analysis methods. Shortly are introduced also the basic sorting and search algorithms and their efficiency. This course discusses problems from a variety of areas such as data structuring, algorithm design and algorithm analysis. In this section, we will examine some fundamental data structures: lists, stacks, queues, trees, graphs. The course covers exchange and shuttle sort algorithms.

Learning outcomes:
By the end of this course, students will be able to: • identify and describe standard data types used in programming language; • give an example of algorithms and analyze the efficiency of algorithm depending on number of operations within it; • describe and use the array as basic data structure; • identify, implement and describe the efficiency of data sorting algorithms: linear, linear barrier, binary algorithm, interpolation methods; • identify, implement and describe the efficiency of data sorting algorithms: exchange, shuttle, selection, insertion, Shellsort and quicksort; • search symbol substring within a string; • give an examples and describe dynamic data structures: list, stack, deque, queue, binary tree and graph;

- write a program, that implements linear list, stack, deque, queue, binary tree and graph;
- implement dynamic data structures in practical tasks;
- explain the purpose of data compression, typical compression parameters;
- understand the importance and necessity of encryption;
- write a program, that implements compression and encryption algorithms.

Course content:

2nd semester – *(DatZ1037-I)* – 2 KP

1. The concept of an information system. Stages of program development.
2. The notion of data type and data structure, their classification.
3. The concept of algorithm, properties, types of records, examples.
4. Basic algorithmic structures (linear, branching, cycles) and implementation for solving various tasks.
5. Simple methods of analysis of algorithms. The concept of algorithm efficiency.
6. An array as a part of the fundamentals of data structures. Organization of data in one-dimensional, two-dimensional array. Symbol strings.
7. The information search process. Data search algorithms: linear and linear barrier, binary algorithm, interpolation methods. Efficiency analysis of search methods.
8. Data sorting algorithms: exchange, shuttle, selection, insertion, Shellsort and quicksort. Efficiency analysis of sorting methods.
9. Symbol substring searching within a string: direct search, Knuth-Morris-Pratt, Boyer-Moore algorithm and Rabin-Karp algorithm. Efficiency analysis of searching methods.
10. Recursion. Applying recursive functions in programming.

3rd semester - *(DatZ2008-II)* – 2 KP

11. Lists. The organization of lists in computer memory. Types of lists. The main operations with lists.
12. The concept of stack, deque, queue, their organization and implementation.
1. The concept of tree structure, organizing tree structure data in the computer memory. Tree traversal algorithms.
13. Types of trees: binary trees, binary search trees, AVL Trees, Red-Black trees.
14. The concept of graph, review of graph algorithms.
15. Data compression. Lossless and lossy data compression algorithms.
16. Information encryption. History of cryptography development. Symmetric encryption algorithms. Asymmetric encryption algorithms..

Course plan:

Course structure: lectures – 32 hrs, practical work - 32 hrs.

2nd semester - *(DatZ1037-I)*
Course structure: lectures – 16 hrs, practical work - 16 hrs.

Lecture topics:

1. The concept of an information system. Stages of program development. The notion of data type and data structure, their classification. The concept of algorithm, properties, types of records, examples.
2. Basic algorithmic structures (linear, branching, cycles) and implementation for solving various tasks. Simple methods of analysis of algorithms. The concept of

algorithm efficiency.
3. An array as a part of the fundamentals of data structures. Organization of data in one-dimensional, two-dimensional array. Symbol strings.
4. The information search process. Data search algorithms: linear and linear barrier, binary algorithm, interpolation methods. Efficiency analysis of search methods.
5. Data sorting algorithms: exchange, shuttle, selection, insertion, Shellsort and quicksort. Efficiency analysis of sorting methods.
6. Symbol substring search within a string: direct search, Knuth-Morris-Pratt, Boyer-Moore algorithm and Rabin-Karp algorithm. Efficiency analysis of searching methods.
7. Recursion. Applying recursive functions in programming.

Seminar/practical work/laboratory work topics:
1. Data search algorithms: linear and linear barrier.
2. Data search algorithms: binary algorithm and interpolation methods.
3. Data sorting algorithms: exchange and shuttle.
4. Data sorting algorithms: selection and insertion.
5. Data sorting algorithms: Shellsort and quicksort.
6. A direct symbol substring searching.
7. Symbol substring searching within a string: Knuth-Morris-Pratt algorithm.
8. Symbol substring searching within a string: Boyer-Moore algorithm and Rabin-Karp algorithm.

3rd semester - *(DatZ2008-II)*
Course structure: lectures – 16 hrs, practical work - 16 hrs.

Lecture topics:
1. Lists. The organization of lists in computer memory. Types of lists. The main operations with lists.
2. The concept of stack, deque, queue, their organization and implementation.
3. The concept of tree structure, organizing tree structure data in the computer memory.
4. Tree traversal algorithms.
5. Types of trees: binary trees, binary search trees, AVL Trees, Red-Black trees.
6. The concept of graph, review of graph algorithms.
7. Data compression. Lossless and lossy data compression algorithms.
8. Information encryption. History of cryptography development. Symmetric encryption algorithms. Asymmetric encryption algorithms.

Seminar/practical work/laboratory work topics:
1. The practical implementation of one-way linear list.
2. The practical implementation of one-way linear list.
3. The practical implementation of stack, deque and queue.
4. The practical implementation of binary search tree.
5. The implementation of binary tree traversal algorithm.
6. The implementation of binary tree traversal algorithm.
7. The practical implementation of data compression algorithm.
8. The implementation of data encryption algorithm.

Requirements for awarding credit points:

2nd semester - *(DatZ1037-I)*

Assessment.
Regular attendance of classes - at least 80% of classes.
Course grade depends on attendance of classes, designed programs and test marks.
During the course all required tests and programs have to be written.
Tests: "Sorting algorithms", "Search algorithms".
Program writing and presentation of programs, that implement the following algorithms -

- search: linear, linear barrier, binary, interpolation method, direct, Knuth-Morris-Pratt, Boyer-Moore and Rabin-Karp algorithm;
- sorting: exchange, shuttle, selection, insertion, Shellsort, quicksort.

3rd semester - *(DatZ2008-II)*
Exam.
Regular attendance of classes - at least 80% of classes.
Course grade depends on attendance of classes, designed programs and test marks.
During the course all required tests and programs have to be written.
Tests: "Binary tree traversals", "Types of graph models".
Program writing and presentation of programs, that implement the following algorithms -

- One-way linear list;
- Stack, deque, queue;
- Binary search tree and tree traversal;
- Data archiver (archiving and unpacking);
- Data encryption and decryption.

Compulsory reading:

1. Donald E. Knuth. The Art of Computer Programming. Addison-Wesley, 1973.
2. Dinamiskās datu struktūras. - Lūse Aija, Lūsis Reinis, 2001
3. Т.Кормен, Ч.Лейзерсон, Р.Ривест. Алгоритмы: построение и анализ: М.:МЦНМО, 2000
4. Дж.Макконнелл. Основы современных алгоитмов. - Москва, ЗАО РИЦ "Техносфера", 2004. – 366 с.
5. Вирт Н. Алгоритмы и структуры данных. – СПб.: Невский Диалект, 2001.
6. С.Д. Кузнецов, ИСП РАН, Центр Информационных Технологий, Методы сортировки и поиска.

Further reading:

1. Kārtošanas un meklēšanas uzdevumi. - Gailītis Artis, Andžāns Agnis, Kudapa Ieva, Ramāna Līga, Johannesons Benedikts, 1999
2. Альфред В. Ахо, Джон Э. Хопкрофт, Джеффри Д. Ульман Структуры данных и алгоритмы. - Издательский дом "Вильямс", 2000
3. А.Ахо, Дж. Хопкрофт, Дж. Ульман. Построение и анализ вычислительных алгоритмов.- Издательский дом “Вильямс”, 2000.-384 с.
4. Матьяш В.А, Путилов В.А., Фильчаков В.В., Щёкин С.В Структуры и алгоритмы обработки данных.- Аппатиты, КФ ПетрГУ, 2000. - 80 с.
5. A.Menezes, P.van Oorshot, S.Vanstone. Handbook of Applied Cryptography – CRC Press Inc., 1997.
6. Кнут Д.Э. Искусство программирования = The Art of Computer Programming.-Москва: Вильямс, 2000. Т.3 Сортировка и поиск. - 822 lpp., Т.1 Основные алгоритмы. - 720 lpp.

7. Левитин А.В. Алгоритмы. Введение в разработку и анализ - издательство "Вильямс", 2006.
8. Каррано Ф.М., Причард Дж.Дж. Абстракция данных и решение задач на C++. Стены и зеркала. - М.:"Вильямс", 2003.
9. С.Окулов. Программирование в алгоритмах (2-е издание). издательство "Бином.Лаборатория знаний", 2006.
10. B.Smith, L.Rowe. “Algorithm for manipulating compressed images.” Computer Graphics and applications. September 1993.
11. Миано Дж. Форматы и алгоритмы сжатия изображений в действии. Серия: "Практика программирования" Издатель: "ТРИУМФ", 2003.
12. А. Ратушняк, В. Юкин, Д. Ватолин, М. Смирнов Методы сжатия данных. Устройство архиваторов, сжатие изображений и видео "Диалог-МИФИ" 2002., 384 стр.
13. Вельшенбах М. Криптография на Си и C++ в действии "Триумф" 2004 г. 464 стр.
14. Брюс Шнайер Прикладная криптография. Протоколы, алгоритмы, исходные тексты на языке Си "Триумф" 2002 г. 816 стр.
15. Водолазский В. Коммерческие системы шифрования: основные алгоритмы и их реализация. Часть 1. // Монитор. -1992. - N 6-7. - с. 14 - 19.
16. Ковалевский В., Максимов В. Криптографические методы. // КомпьютерПресс. - 1993. - N 5. - с. 31 - 34.
17. Д.С. Ватолин. “Сжатие статических изображений”. Открытые системы, №8(29), 1995

Periodicals and other sources

1. V.Vagale. Kursa mācību materiāli: http://lapas.du.lv/vvagale
2. O.Perevalova. Lekciju konspekti. http://www.lapas.dau.lv/ole/alg.html
3. Т.Кормен, Ч.Лейзерсон, Р.Ривест. Алгоритмы: построение и анализ: М.:МЦНМО, 2000 - http://www2.cs.pitt.edu/~kirk/
4. John Morris. Data Structures and Algorithms. - 1998. http://ciips.ee.uwa.edu.au/~morris/Year2/PLDS210/index.html
5. http://www.citforum.ru/programming/theory/sorting/sorting1.shtml

Course name in English:

Algorithms and Data Structures

Course annotation in English:

The course is intended for students of professional bachelor study program "Information Technologies" (42481).
This course discusses problems from a variety of areas such as data structuring, algorithm design, and algorithm analysis. We shall investigate the performance of some searching and sorting algorithms. In this section, we will examine some fundamental data structures: lists, stacks, queues, trees, graphs.