Description of courses

for 2d semester of profile “Logistics Analytics” of the master study program

“Applied Mathematics and Informatics”

at the Belarusian State University (BSU)

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# Overview

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| No | The name of the academic discipline | Hours in class | Total hours | Credits | Evaluation (grade/pass) |
| 1 | Business Process Visualization | 40 | 126 | 3.5 | pass |
| 2 | Computational Geometry and Geometric Modeling | 40 | 96 | 3 | grade |
| 3 | Mathematical and Computer Prediction | 60 | 198 | 6 | grade |
| 4 | Routing Problems in Logistics | 60 | 120 | 3.5 | grade |
| 5 | Models and Methods for Solving Optimization Problems in Logistics | 40 | 126 | 3.5 | grade |
| 6 | Heuristic Methods for Logistics Problems | 40 | 126 | 3.5 | pass |
| 7 | Intellectual Control Systems | 40 | 126 | 3.5 | pass |
| 8 | Data Storage and Processing Computer Technology | 40 | 126 | 3.5 | pass |
| - | Total | 360 | 1044 | 30 | - |

# **Business Process Visualization**

## About the course

The course "Business Process Visualization" acquaints graduate students with theoretical aspects, principles of design, implementation of modern analytical solutions, processes of data integration and consolidation.

The goal of the discipline is to develop the skill of developing applications for collecting and structuring information from various sources using automated methods in real-time systems, organizing data warehouses, analyzing data in order to extract information and establish dependencies in data.

## The student's learning outcomes after completing the course

The students will study the key aspects of building data warehouses, star and snowflake models; ways of organizing data storages with the implementation of constant replenishment of the storage in real-time or batch filling; methods of data visualization, typical visual structures for data display; data analysis schemes: ABC analysis, XYZ analysis, bcg analysis**.**

The students will be able to use the studied techniques and algorithms to build the "From data to Profit" process.

## Forms of teaching and learning

2 hours of lectures and practical lessons per week (126 total hours, 40 hours in class).

## Evaluation

There is a total of 3.5 credits for this course. One final assignment and one report on a given topic will be evaluated with a numerical grade (1 - 10). To get credit, both grades should be at least 4.

# **Computational Geometry and Geometric Modeling**

## About the course

The course "Computational Geometry and Geometric Modeling" includes sections that describe the basic algorithms for vector graphics, computational geometry and geometric modeling. The study of the discipline allows to gain the knowledge that necessary for successful work in the field of Computer-aided design and Information Technology.

The goal of the discipline is to provide the master students with the knowledge that allow them to independently develop software applications and computational components to effectively solve computational geometry problems and to create complex geometric models.

## The student's learning outcomes after completing the course

The students will learn stable methods for calculating geometric predicates; efficient algorithms for geometric search on a plane; efficient algorithms for finding the intersection of objects on a plane; efficient algorithms for constructing the convex hull of a set of points on a plane and solving problems of geometric proximity; algorithms for calculating geometric projections of three-dimensional objects; basic algorithms for 3D reconstruction; methods for solving problems of geometric proximity; methods for modeling compound curves and surfaces of varying degrees of smoothness.

The students will be able to develop effective algorithms for solving geometric problems; develop computational and graphic components of CAD and gaming graphics applications.

The student will possess skills in solving computational geometry problems; knowledge of geometric modeling methods.

## Forms of teaching and learning

2 hours of lectures and practical lessons per week (96 total hours, 40 hours in class).

## Evaluation

There is a total of 3 credits for this course. To take the exam, students should do and present several assignments, typically 5-6. The exam is oral and will be evaluated with a numerical grade (1 - 10). To get credit, the grade should be at least 4.

# **Mathematical and Computer Prediction**

## About the course

The course "Mathematical and Computer prediction" is studying methods and algorithms for computational analysis and modeling of complex systems and processes as well as gives mathematical descriptions of these system and processes.

The objectives of teaching the discipline "Mathematical and Computer Prediction" are to familiarize with the statistical packages for modeling and forecasting complex systems and to perform a number of tasks.

## The student's learning outcomes after completing the course

The students will study linear and nonlinear regression models, regression models with the autocorrelated structure of errors, heteroscedastic regression models; Linear processes; Vector autoregression; Estimation methods and forecasting; nonlinear time series and non-stationary processes, co-integration, unit root test.

Time series with seasonal effects, time series with gaps and outliers, discrete-time series and Markov chains will also be studied.

The students will be able to apply the above knowledge in practice using the R language.

## Forms of teaching and learning

3 hours of lectures and practical lessons per week (198 total hours, 60 hours in class).

## Evaluation

There is a total of 6 credits for this course. To take the exam, students should do and present 8 assignments and 1 oral report. The exam is oral and will be evaluated with a numerical grade (1 - 10). To get credit, the grade should be at least 4.

# **Routing Problems in Logistics**

## About the course

The course "Routing Problems in Logistics" is studying arc routing problems, traveling salesperson problem and its variants, and different variants of vehicle routing problem.

Emphasis will be placed on the heuristic methods for solving problems.

## The learning outcomes after completing the course

The students will study arc routing problems in logistics such as the Postman Problem, the Chinese Postman Problem, the Rural Postman problem, and the algorithms for solution of these problems. The Travelling Salesperson Problem and its variants are studied, including the classical construction heuristics, the Minimal Spanning Tree heuristics and the Savings heuristic for their solution, as well as Lower Bounds and solution evaluation. The Capacitated Vehicle Routing Problem, the Vehicle Routing Problems with Pickups and Deliveries and the Inventory Routing Problems together with the corresponding solution algorithms are studied.

The students will be able to solve all the problems studied using the classical construction heuristics and to evaluate the quality of solutions.

## Forms of teaching and learning

3 hours of lectures and practical lessons per week (120 total hours, 60 hours in class).

## Evaluation

There is a total of 3.5 credits for this course. To take the exam, students should do and present 6 assignments. The exam is oral and will be evaluated with a numerical grade (1 - 10). To get credit, the grade should be at least 4.

# **Models and Methods for Solving Optimization Problems in Logistics**

## About the course

The course "Models and Methods for Solving Optimization Problems in Logistics" is studying various optimization problems in logistics, specifically optimization problems with integer and binary decision variables, and how to formulate and solve them.

Emphasis will be placed on modeling and solving the various types of Integer and Mixed Integer Programming Problems in Logistics using mathematical programming languages and solvers software.

## The student's learning outcomes after completing the course

The students will study the use of binary variables in optimization problems in logistics for modeling fixed costs, yes/no decisions, logical connections, linearization and approximation of non-linear functions and piecewise linear functions, and when only a discrete set of variable values is allowed.

The students will learn the various types of logistics planning problems with integer variables such as inventory and production management problems using setup costs, economy of scale and capacity expansion; location-allocation problems such as facility location, vendor selection, project selection, bin-packing; assignment problems such as matching, set covering, crew scheduling; sequencing problems such as machine scheduling and vehicle routing. The students will be able to model logical constraints used for logical connections, for distinguishing states, if constraints hold, for disjunctive constraints.

Specifically, students will be able to model location problems, network design problems, vehicle routing problems including traveling salesman problem and its variants, capacitated and periodic routing problems, and solve them directly or with the two-stage solution methods using the AMPL algebraic modelling programming language and the CPLEX solver.

## Forms of teaching and learning

2 hours of lectures and practical lessons per week (126 total hours, 40 hours in class).

## Evaluation

There is a total of 3.5 credits for this course. To take the exam, students should do and present 6 assignments. The exam is oral and will be evaluated with a numerical grade (1 - 10). To get credit, the grade should be at least 4.

# **Heuristic Methods for Logistics Problems**

## About the course

The course "Heuristic Methods for Logistics Problems" aims to study the basic algorithmic methods for analysis and development of effective heuristic algorithms to solve complex problems, especially combinatorial optimization problems.

The purpose of this curriculum is to provide knowledge decision making and data-driven optimization, models and algorithms.

## The student's learning outcomes after completing the course

The students will study basic concepts and classification of the heuristics, learn construction algorithms and local search algorithms, various metaheuristics, approximation algorithms with guaranteed error bounds. The student will learn how to design such algorithms and will know how to develop new ones.

The students will be able to implement efficient heuristics in a programming language such as C++, Python, etc.

## Forms of teaching and learning

2 hours of lectures and practical lessons per week (126 total hours, 40 hours in class).

## Evaluation

There is a total of 3.5 credits for this course. Students should do and present 3 assignments which will be evaluated with a numerical grade (1 - 10). To get credit, both grades should be at least 4.

# **Intellectual Control Systems**

## About the course

The course "Intellectual Control Systems" aims to explain how fundamental business processes interact with Enterprise Resource Planning (ERP) systems in functional areas such as Sales and Distribution, Production Planning, Financial Accounting, Human Capital Management, and more.

Emphasis will be placed on using S/4HANA in SAP GUI or Fiori interfaces for implementing the above processes.

## The student's learning outcomes after completing the course

The students will learn to name functionalities, define central organizational units and summarize master data from different ERP modules.

The students will be able to explain standard processes and integration points and implement them using S/4HANA. As an example, GBI global company processes will be used.

## Forms of teaching and learning

2 hours of lectures and practical lessons per week (126 total hours, 40 hours in class).

## Evaluation

There is a total of 3.5 credits for this course. To get credit, students should do and present 3 assignments.

# **Data Storage and Processing Computer Technology**

## About the course

The course "Data Storage and Processing Computer Technology" provides an introduction to the basics of in-memory databases in an ERP system and its use in analytical applications. It also introduces native development, data mining, spatial processing, text analytics, and graph processing.

The emphasis will be placed on using computer technology for data storage and processing on the example of SAP HANA.

## The student's learning outcomes after completing the course

The students will learn basic concepts of in-memory databases, SAP HANA overview, analytics in SAP HANA. They will be able to build modern web applications, build Apps on SAP HANA, and build Fiori applications.

The students will learn overview of data mining and big data fields, and how they are related to SAP HANA. They will be able to create and access spatial data in SAP HANA, load social media data into the database, perform text analysis, visualize analysis results with SAP Lumira / Predictive Analytics; learn how are graphs implemented in SAP HANA and will be able to implement graph algorithms.

## Forms of teaching and learning

2 hours of lectures and practical lessons per week (126 total hours, 40 hours in class).

## Evaluation

There is a total of 3.5 credits for this course. To get credit, students should do and present 1 assignment and 1 report.