Syllabus
Course Program

Integrated Computer Systems for Design and Analysis

Specialty
113 – Applied mathematics

Institute
Institute of Computer Modeling, Applied Physics and Mathematics

Educational program
Computer and Mathematical Modeling

Department
Mathematical Modeling and Intelligent Computing in Engineering (161)

Level of education
Master's level (1 year 4 months)

Course type
Special (professional), Elective

Semester
2

Language of instruction
English

Lecturers and course developers

Vitalii Ovcharenko
(responsible lecturer)
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PhD, associate professor of the department of mathematical modeling and intelligent computing in engineering

Author and co-author of more than 30 scientific and methodical publications and patents.

More about the lecturer on the department's website

General information

Summary

The discipline "Integrated computer systems of design and analysis" provides students with comprehensive knowledge and skills in the field of automation and integration of software systems using various approaches (COM, Automation, .NET and others). The course includes lectures and laboratory work on the development of software interfaces, integration with automated design systems, office applications, complex systems designed for engineering calculations, analysis and simulation of physical processes, providing students with the necessary tools for a successful career in the field of engineering and software development.

Course objectives and goals

The aim of the course is to study the basics of application integration technologies (COM, Automation, .NET) and to gain practical skills in integrating applications with computer-aided design systems, complex systems designed for engineering calculations, analysis and simulation of physical processes and other types of applications.

Format of classes

Lectures, laboratory works, consultations. Final control in the form of a credit.

Competencies

GC1. Ability to generate new ideas (creativity) and non- standard approaches to their implementation.
GC3. Ability to master modern knowledge, formulate and solve problems.
PC3. Ability to develop methods and algorithms for the
construction, research and software implementation of mathematical models in engineering, physics, biology, medicine and other fields and to analyse them.
PC4. Ability to develop and research mathematical and computer models, conduct computational experiments and solve formalised problems using specialised software.
PC7. Ability to design and develop software to solve formalised problems, including systems with large amounts of data.
PC8. Ability to formalise and build data or knowledge models, obtain relevant knowledge from large amounts of data, choose data mining methods to solve problems.

Learning outcomes

LO5. Justify and, if necessary, develop new algorithms and software tools for solving scientific and applied problems, apply, modify and investigate analytical and computational methods for solving them.
LO7. Solve computer modelling problems by using and developing modern software tools, in particular, distributed, parallel and cloud programming methods.
LO8. Develop and implement algorithms for solving applied problems, system and application software of information systems and technologies.

Student workload

The total volume of the discipline is 120 hours (4 ECTS credits): lectures - 32 hours, laboratory work - 16 hours, independent work - 72 hours.

Course prerequisites

Methods of mathematical modeling and data analysis .
Basic knowledge of programming . Basics of C# . Basics of using automated design and calculation systems. Python basics

Features of the course, teaching and learning methods, and technologies

Laboratory classes use up-to-date data from open sources. Learning materials are available to students via OneDrive.

Program of the course

Topics of the lectures

Topic 1. Application integration technologies.
Overview of COM (Component Object Model), Automation and .NET technologies. Historical context and evolution of technologies. Fundamental concepts and principles.
Topic 2. .NET as a tool for creating applications based on component approaches
Basics of developing and using .NET class libraries. Examples of .NET API construction.
Topic 3. Integration with office applications
Using Microsoft.Office.Interop.Excel and Microsoft.Office.Interop.Word in .NET. Class architecture. Data exchange between applications.
Topic 4. Fundamentals of AutoCAD .NET API
Principles of exposing AutoCAD objects using the AutoCAD .NET controlled application programming interface. Learning the hierarchy of AutoCAD .NET API objects
Topic 5. Fundamentals of AutoCAD .NET API - 2
Graphical and non-graphical objects. Collection objects. Non-native graphic and non-graphic objects. Development of applications for creating and modifying objects stored in the drawing file database.
Topic 6. Fundamentals of AutoCAD .NET API - 3
Development of extensions for AutoCAD. Frame, surface and solid 3D modeling. Complex integration scenarios and practical examples.

Topic 7. Integration with Ansys
Using ANSYS Parametric Design Language (APDL) and PyMAPDL (Python wrapper for APDL) to import models, enter geometric and physical parameters, define materials and loading conditions, and analyze and optimize engineering structures in the ANSYS environment.
Topic 8. Integration with Ansys - 2
Application Customization Toolkit ANSYS ACT 2021. Interfaces, API and XML tags. Using Python and C# programs in ACT to develop extensions for Ansys. Practical examples of developing Ansys extensions to solve complex analysis tasks.

Topics of the workshops

Not appliable

Topics of the laboratory classes

Topic 1. Using the Component Object Model
Development of a client application that interacts with an already developed educational server application using COM technology
Topic 2. .NET as a tool for creating applications based on component approaches
Development of a class library and a client application that interact through .NET
Topic 3. Automation of tasks related to documents
Applications for creating reports using Microsoft.Office.Interop.Word
Topic 4. Integration with Excel
Development of an application that builds diagrams in MS Excel using Microsoft.Office.Interop.Excel
Topic 5. AutoCAD .NET API
Development of an application that performs drawing in AutoCAD
Topic 6. AutoCAD .NET API - 3D
Development of an application that performs the construction of three-dimensional objects in AutoCAD
Topic 7. AutoCAD .NET API - Extensions
Development of an AutoCAD extension that allows to build and export a parametrically specified model for further calculations
Topic 8. Ansys APDL
Development of an application for automating the calculation of structural strength in Ansys using APDL or PyMAPDL
Topic 9. Ansys ACT
Development of an Ansys extension that allows to import the model built as part of laboratory work #7 and calculate its strength.

Self-study

Elaboration of lecture material and preparation of reports based on the results of laboratory work. Execution of the calculation task. Independent study of the possibilities of integration with other software complexes..

Course materials and recommended reading

1 Andrew Troelsen, Philip Japikse, Pro C# 10 with .NET 6: Foundational Principles and Practices in Programming, Apress, 2022
2 https://help.autodesk.com/view/OARX/2024/ENU/?guid=GUID-C3F3C736-40CF-44A0-9210-55F6A939B6F2
3 Susanna Young, Jeff Strain, Introduction to the ANSYS Parametric Design Language (APDL), Phoenix Analysis & Design Technologies, 2013
4 https://storage.ansys.com/act/v211/ACTReferenceHTML/index.html

Assessment and grading

Criteria for assessment of student performance, and the final score structure

100% of the final grade consists of the results of the assessment in the form of a test (35%) and the current assessment based on the results of the performed laboratory work (65%).

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.
Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by	Date August 30, 2023	Head of the department Oleksii VODKA
	Date August 30, 2023	Guarantor of the educational and professional program (1 year 4 months) Oleksiy LARIN