



## Syllabus Course Program



# Application Development Using the Component Approach

### 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



### Oleksii Vodka (responsible lecturer)

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PhD, docent, Head of Mathematical modelling and intellectual computing in  
engineering department

General information, number of publications, main courses, etc.

[More about the lecturer on the department's website](#)

## General information

### Summary

This discipline introduces the applied aspects of application development using component-based approaches and allows you to learn how to develop software for integration into existing powerful systems for design and engineering calculations to solve a specific class of problems or to calculate a specific class of structures. In this case, the integration utilizes the wide capabilities of existing systems and provides the user with a more convenient and intuitive interface than universal systems offer.

### Course objectives and goals

The purpose of the discipline is to teach students the basics of parametric design and automation of engineering calculations in modern computer-aided design (CAD) systems, such as SolidWorks and ANSYS.

Objectives of the discipline: to know the principles and methods of parameterization of geometric models in CAD; to be able to use parameter tables and configurations; know the concepts of application programming interface (API) and basic software integration technologies such as COM, OLE Automation and dot NET; to be able to develop macros, application libraries and controller programs to automate geometry design and assembly editing in SolidWorks CAD; know the basics of implementing engineering calculations of various types using the finite element method (FEM) in SolidWorks CAD modules "Simulation", "Motion" and "Flow Simulation"; to be able to perform analysis of kinematics, dynamics, strength, optimization and dynamics of fluid and gas for various structures in SolidWorks CAD modules; know the basic concepts, structure and application of the ANSYS parametric design language (APDL); - be

able to develop and apply macros and controller programs to automate the calculation of the strength of spatial structures in ANSYS.

## Format of classes

Lectures, laboratory classes, consultations, self-study. 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

Modeling skills in CAD/CAE systems. Skills in creating software applications with knowledge of the C# programming language and the .NET platform.

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

Teaching methods: Lectures, laboratory work, consultations.

## Program of the course

### Topics of the lectures

#### Topic 1: Creating parametric geometry.

1.1 Parameterize geometric models in SolidWorks CAD using parameter and configuration tables.

1.2 Consideration and explanation of an example of parameterization of a prefabricated structure in SolidWorks CAD using parameter and configuration tables.

1.3 Parameterizing geometric models in SolidWorks CAD using equations and the Visual Basic for Applications programming language.

1.4 Consideration and explanation of an example of parameterization of a prefabricated structure in SolidWorks CAD using equations and the Visual Basic for Applications programming language.

#### Topic 2. SolidWorks CAD programming interface.

- 2.1 Understand the application programming interface (API) as it relates to SolidWorks and review existing applications for SolidWorks.
- 2.2 The structure of SolidWorks CAD automation objects and an overview of the main integration interfaces with this CAD.
- 2.3 Automate geometry design in SolidWorks CAD by writing and developing macros.
- 2.4 Consideration and explanation of an example of automating the design of part geometry in SolidWorks CAD using macros.

**Topic 3: Software integration technologies.**

- 3.1 Introduction to modern programming technologies and the concept of interfaces.
- 3.2 Theoretical foundations of the model of multicomponent COM.
- 3.3 Consider and explain an example of creating a local server and client application using COM technology.
- 3.4 Theoretical foundations of OLE Automation programming technology.
- 3.5 Consideration and explanation of the example of creating a local server and controller using OLE Automation technology.

**Topic 4. Design automation in SolidWorks CAD.**

- 4.1 Develop application libraries (.dll) integrated into the SolidWorks CAD graphical interface using COM technology.
- 4.2 Development of controller programs (.exe) to automate the construction of geometric models in SolidWorks CAD using dot NET technology.
- 4.3 Development of controller programs (.exe) to automate the editing of structural assemblies in SolidWorks CAD using dot NET technology.

**Topic 5. Engineering calculations in SolidWorks CAD modules.**

- 5.1 Fundamentals of implementing engineering calculations of various types using FEM in the SolidWorks CAD module "Simulation" .
- 5.2 Consideration and explanation of an example of solving a design optimization problem using multidisciplinary engineering calculations .
- 5.3 Theoretical Foundations and Basic Concepts of Kinematics and Dynamics Analysis .
- 5.4 Fundamentals of implementing the analysis of kinematics and dynamics of complex mechanisms in the SolidWorks CAD module "Motion" for the purpose of strength calculation .
- 5.5 Consideration and explanation of an example of calculating the strength of a mechanism with regard to the forces and reactions obtained in the calculation of dynamics .
- 5.6 Theoretical foundations and basic concepts of the analysis of fluid and gas dynamics .
- 5.7 Fundamentals of analyzing the dynamics and flow of liquids and gases in the SolidWorks CAD module "Flow Simulation" for strength calculation .
- 5.8 Consideration and explanation of an example of calculating the strength of a structure with consideration of the dynamic effects of gas or liquid flow .

**Topic 6: Automation of ANSYS CAD.**

- 7.1 Basic concepts, structure and application of APDL (ANSYS parametric design language) .
- 7.2 Practical aspects of developing and using macros in ANSYS CAD .
- 7.3 Integration with ANSYS CAD and development of controller programs (.exe) for automation of strength calculation of spatial structures .

**Topic 8: Automation of the SolidWorks CAD module "Simulation".**

- 8.1 Structure of automation objects of the SolidWorks "Simulation" CAD module and an overview of the main integration interfaces with this module .
- 8.2 Consideration and explanation of the example of developing a controller program (.exe) for automating the calculation of structural strength in the SolidWorks CAD module "Simulation" .

**Topics of the workshops**

Not applicable

## Topics of the laboratory classes

- Work 1. Parameterization of the card reader model in SolidWorks CAD using parameter and configuration tables
- Work 2. Parameterization of the card reader model in SolidWorks CAD using equations and VBA programming language
- Work 3. Developing a local server and client application using COM/OLE technology
- Work 4. Development of an application library (.dll) integrated into the SolidWorks CAD graphical interface
- Work 5. Development of a controller for automating assembly editing in SolidWorks CAD using dot NET technology
- Work 6. Calculation of the strength of internal combustion engine parts taking into account dynamic loads at the joints
- Work 7. Calculation of the strength of an advertising billboard taking into account the load from a gusty wind flow
- Work 8. Development of an application for automation of structural strength calculations in ANSYS CAD
- Work 9. Development of a controller for automation of strength calculation in the SolidWorks CAD module "Simulation"
- Work 10. Development of a controller for automation of assembly editing in SolidWorks CAD using dot NET technology
- Work 11. Development of an application for automation of structural strength calculations in ANSYS CAD
- Work 12. Development of a controller for automation of strength calculation in the SolidWorks CAD module "Simulation"

## Self-study

Independent work involves completing a calculation task, completing additional tasks and preparing reports on laboratory work.

Also self-study includes preparation to laboratory classes and report preparation on passed laboratory classes

## Course materials and recommended reading

1. Malpass, L. (2013). SolidWorks API Series 1: Advanced Product Development. (n.p.).
2. Spens, M. (2021). Automating SOLIDWORKS 2021 Using Macros. (n.p.): SDC Publications (Schroff Development Corporation).
3. Zeid, I. (2021). Mastering SolidWorks. United Kingdom: Pearson Education.

## Assessment and grading

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

The total score (max. 100 points) consists of two components:

- 1: Test on the theoretical part based on lecture materials 40 points.
2. Grade for the laboratory workshop (50 points).
3. Calculation task (10 points)

The assessment of independent work is carried out by asking questions on relevant topics during the defense of laboratory work and is an integral part of the assessment of practical work.

### 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