MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

ODESSA I.I. Mechnikov NATIONAL UNIVERSITY

Chair *mechanics, automation and information technologies*

APPROVED
Vice-rector for scientific and pedagogical work

_____ (_____)

«___» _____ 2022

WORKING PROGRAM OF EDUCATIONAL DISCIPLINE

Visualization of mechanical processes

(name of academic discipline)

Level of higher education: *Second (master's)*

Field of knowledge: 12 "Information technologies"

Specialty: 126 "Information systems and technologies"

Specialization: _____

Educational and professional program: "INFORMATION SYSTEMS AND TECHNOLOGIES"

ONU
2022

Work program of the educational discipline "Visualization of mechanical processes". – Odesa: ONU, 2022. – 14 p.

Developer:
Viktor Eduardovych Volkov, Sc.D. (tech.), professor.

The work program was approved at the meeting of the department
mechanics, automation and information technologies

Protocol No. 1 of "26" 08 2022

Head of the department _____ (Alla RACHINSKA)
(signature)

Agreed with the EPP guarantor

"INFORMATION SYSTEMS AND TECHNOLOGIES"

_____ (Eugene MALAKHOV)
(signature)

Approved by the educational and methodological commission (EMC) for IT specialties of the FMPhIT

Protocol No. 1 of "31" 08 2022

Head of EMC _____ (Alla Rachynska)
(signature)

Reviewed and approved at the department meeting
mechanics, automation and information technologies

Protocol No. 1 of "28" 08 2023

Head of the department _____ (Alla RACHINSKA)
(signature)

Reviewed and approved at the department meeting
mechanics, automation and information technologies

Protocol No.____ of "____" _____ 202_

Head of the Department _____ (Alla RACHINSKA)
(signature)

1. Course description

<table>
<tr><td rowspan="2">Name of indicators</td><td rowspan="2">Field of knowledge, specialty, specialization, level of higher education</td><td colspan="2">Characteristics of the academic discipline</td></tr>
<tr><td>Full-time education</td><td>External form of education</td></tr>
<tr><td rowspan="14">The total number of:

credits - 4

hours - 120

content modules - 2</td><td rowspan="14">Branch of knowledge
12 "Information technologies"
(code and name)

Specialty
126 "Information systems and technologies"
(code and name)

Specializations:

_____
(name)

Level of higher education:
Second (master's)</td><td colspan="2">Mandatory OP component</td></tr>
<tr><td colspan="2">Year of preparation:</td></tr>
<tr><td>2nd _</td><td>2nd _</td></tr>
<tr><td colspan="2">Semester</td></tr>
<tr><td>3rd _</td><td>3rd _</td></tr>
<tr><td colspan="2">Lectures</td></tr>
<tr><td>12 hours</td><td>12 hours</td></tr>
<tr><td colspan="2">Practical, seminar</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Laboratory</td></tr>
<tr><td>12 - hours</td><td>12 - hours</td></tr>
<tr><td colspan="2">Independent work</td></tr>
<tr><td>96 hours</td><td>96 hours</td></tr>
<tr><td colspan="2">Final control form:
exam</td></tr>
</table>

2. The purpose and tasks of the educational course

Aim

The aim is to provide theoretical knowledge of mechanics and practical skills in the application of methods and means of visualizing mechanical processes using modern computer technology and object-oriented programming languages for solving current problems of information technology and automatic control.

The purpose of the lectures is to master the laws of mechanics and general methods of solving mechanics problems, as well as the rules of developing applied mathematical and software for visualization of various mechanical processes.

The purpose of conducting laboratory work is mastering and in-depth assimilation of techniques for using modern programming languages in the development of calculation algorithms for solving mechanics problems and visualization of correspondent mechanical processes.

Task:

The task of the discipline for students is to acquire theoretical knowledge and practical skills in the development of application software for visualization of mechanical processes.

The process of studying the discipline is aimed at forming elements of the following **competencies**:

a) general (GC):

GC01. Ability for abstract thinking, analysis, and synthesis.

GC05. Proficiency in assessing and ensuring the quality of work performed.

GCM01. Knowledge of rules for formulating research tasks approaches to goal selection, problem analysis, and methods for problem-solving, rules for presenting results, conducting discussions, and publishing scientific materials.

b) special/professional:

SC04. The ability to develop mathematical, informational, and computer models of objects and processes related to informatization.

SKM03. The ability to mathematically model digital data and apply efficient algorithms for the analysis and transformation of multimedia data in modern information systems.

Program learning outcomes (LO):

LO01. Locate necessary information in scientific and technical literature, databases, and other sources, analyze, and evaluate this information.

LO08. Develop models of information processes and systems of various classes, use methods of modeling, formalization, algorithmization and implementation of models using modern computer tools. Develop models of information processes

and systems of different classes, using methods of modeling, formalization, algorithmization, and model implementation using modern computer tools.

As a result of studying the academic discipline, the student should

know:

- the main problems solved by mechanics;
- the main stages of solving a modern physico-mathematical problem using examples of solving mechanics problems;
- mathematical statements of the main problems of mechanics and their components;
- basic models, methods, algorithms and their software implementation when solving a specific or general problem of mechanics;
- the main elements of modern programming used in the visualization of mechanical processes;
- numerical methods of solving mathematical problems;
- numerical methods of solving systems of nonlinear equations;
- methods of creating computer interfaces for research programs;
- methods of composition of various software modules within the framework of a single application.

be able:

- develop physical and mathematical models of mechanical processes and physical objects;
- to solve problems of mechanics and physics analytically or using numerical methods;
- develop information models of objects;
- apply modern programming languages and software component development environments to solving specific or general physical and mathematical problems;
- develop and apply modern methods of visualization of mechanical processes;
- use software components and forms for designing software implementations, use media for storing calculation results;
- prepare reports on completed tasks, describe software components, etc.;
- perform calculations according to developed programs.

3. **Course content**

Content of the module 1. " General mechanical problems and their solutions"

Topic 1. "Introduction. Mechanical processes and their modeling"

Mechanical movement and mechanical process. Mechanics as the basis of physics. Basic mechanical models. Problems of kinematics, statics and dynamics.

The main stages of solving physical and mathematical problems. Models, methods, algorithms, and software implementation.

Visualization of mechanical and physical processes.

The method of calculating some higher transcendental functions.

Topic 2. "Computer modeling of the movement of a material point in a uniform gravity field"

The general statement of the problem of the movement of a material point in a uniform gravitational field. Analysis of the statement and solution of the problem.

Modeling and visualization of the movement of a material point in a uniform gravity field in the presence of wind force.

Modeling the movement of an elastic ball taking into account its impact on the ground.

Topic 3. "Computer modeling of the movement of a discrete system of material points"

General formulation of the problem of movement of a discrete system of material points. Analysis of the statement of the problem.

Modeling and visualization of the movement of ideal gas molecules as a discrete system of material points.

Content of the module 2. " Visualization of mechanical oscillations"

Topic 4. "General concepts of the theory of oscillations"

General formulation and solution of the problem of free oscillations of a material point. Terminology, basic definitions. Fluctuations in technical systems.

The influence of resistance and constant forces on the free oscillations of a material point.

Visualization of the process of free oscillations of a material point.

Topic 5. "Computer modeling of forced oscillations of a material point"

Forced oscillations of the point. Resonance.

The effect of resistance on forced oscillations of a point. Resonance in the presence of resistance.

Visualization of the process of forced oscillations of a material point.

Topic 6. "Waves as a process of propagation of oscillations"

Formulation of the problem of string oscillations. Analytical solution of the problem by the Dalembert method.

Visualization of the string oscillation process.

4. Course structure

Names of topics	Number of hours									
	Full-time					Correspondence form				
	That's all	including				That's all	including			
		l	p/s	lab	Wed		l	p/s	lab	Wed
1	2	3	4	5	6	7	8	9	10	11
Content module 1 . " General mechanical problems and their solutions"										
Topic 1. "Introduction. Mechanical processes and their modeling"	20	2		2	16	20	2		2	16
Topic 2. "Computer modeling of the movement of a material point in a uniform gravity field"	20	2		2	16	20	2		2	16
Topic 3. "Computer modeling of the movement of a discrete system of material points"	20	2		2	16	20	2		2	16
Together according to the content of the module 1	**60**	**6**		**6**	**48**	**60**	**6**		**6**	**48**
Content module 2. " Visualization of mechanical oscillations"										
Topic 4. "General concepts of the theory of oscillations"	20	2		2	16	20	2		2	16
Topic 5. "Computer modeling of forced vibrations of a material point"	20	2		2	16	20	2		2	16
Topic 6. "Waves as a process of propagation of oscillations"	20	2		2	16	20	2		2	16
Together according to the content of the module 2	**60**	**6**		**6**	**48**	**60**	**6**		**6**	**48**
All hours together	**120**	**12**		**12**	**95**	**120**	**12**		**12**	**96**

5. Topics of seminar classes

Seminar classes are not provided.

6. Topics of laboratory classes

No s/p	Topic name	Number hours	
		ocular	extramural
1	Visualization of the movement of a material point in the field of gravity.	2	2
2	Computer modeling and visualization of the movement of an elastic ball taking into account its impact on the ground.	2	2
3	Visualization of the movement of ideal gas molecules.	2	2
4	Computer modeling and visualization of free oscillations of a material point.	2	2
5	Computer modeling and visualization of forced oscillations of a material point.	2	2
6	Computer modeling and visualization of string oscillations.	2	2
	Together	12	12

7. Topics of practical classes

Practical classes are not provided.

8. Independent work

No s/p	Topic name	Number hours	
		ocular	extramural
1	Topic 1. "Introduction. Mechanical processes and their modeling" Study of point kinematics. Development of software components intended for visualization of point movement.	16	16
2	Topic 2. "Computer modeling of the movement of a material point in a uniform gravity field" Study and visualization of the movement of artificial satellites and planets.	16	16
3	Topic 3. "Computer modeling of the movement of a discrete system of material points" Studying the peculiarities of the movement of gas molecules as material points.	16	16
4	Topic 4. "General concepts of the theory of oscillations" Study of fluctuations in nature and technical systems.	16	16
5	Topic 5. "Computer modeling of forced oscillations of a material point" Study and visualization of resonance phenomena.	16	16
6	Topic 6. "Waves as a process of propagation of oscillations" Study of general concepts of wave theory. Development of software components intended for visualization of wave motion.	16	16
	Together	96	96

9. Teaching methods

Verbal : lecture, consultation.
Visual : illustration of the material in the form of multimedia presentations.
Practical : solving calculation problems; laboratory classes; performance of individual control tasks.

10. Forms of control and evaluation methods

Methods of current \ periodic control : evaluation of the performance of laboratory work and individual control tasks.

Final control : Exam. Interview based on the theoretical material of all meaningful modules; problem solving.

Evaluation criteria

Theoretical training	Practical training
perfectly	
The learner is able to explain the essence of theoretical questions, characterize cause-and-effect relationships, form conclusions and generalizations, freely operate with axiomatics, postulates and their consequences. Able to independently analyze problems, offers alternative approaches to problem solving, or finds additional sources with other methods or software implementations.	The learner is able to independently perform software modeling of mathematical problems and implement them in the form of applications and components. Shows a creative approach to the implementation of the proposed algorithms or offers his own rational ways of performing the assigned tasks. Performs error-free calculations, calculations, and prepares relevant reports. Completed all planned tasks.
fine	
The learner is able to correctly use theoretical material or formulas, understanding their cause-and-effect relationships, and relying on the conclusions and explanations provided in the corresponding methodological support. The learner is able to independently reproduce the proposed methods and algorithms for solving typical tasks and their software implementations.	The learner is able to perform software modeling of mathematical problems without error and implement them in the form of applications and components if there is appropriate methodological support. Shows a thorough approach to the implementation of the proposed algorithms and calculations. Independently corrects errors in calculations or in software components. Completed more than half of all planned tasks.
satisfactorily	

The learner possesses educational material at the reproductive level or reproduces a certain part of it with elements of logical connections. Knows the basic concepts of the educational material, but cannot give a clear interpretation of their content and does not identify cause-and-effect relationships between them, has complications when formulating conclusions and justifications. Cannot qualify the theoretical material according to its purpose.	The learner makes mistakes when performing software modeling and when implementing it in the form of applications and components in the presence of appropriate methodological support. Shows carelessness in the implementation of proposed algorithms and calculations. Not capable of independently correcting errors in calculations or in software components. Completed less than half of planned tasks.
unsatisfactorily	
The learner possesses the educational material only superficially and fragmentarily (without argumentation and justification); unsystematically singles out random features of the subject; does not know how to perform the simplest operations with the objects being studied. When answering current questions, makes significant mistakes of a principled nature.	The learner makes systematic errors when performing software modeling and when implementing it in the form of applications and components in the presence of appropriate methodological support. Unable to understand errors in calculations or in software components pointed out by the teacher. Completed less than a third of all planned tasks.

11. Questions for final control

Content module 1 . **"** General mechanical problems and their solutions"
1. Basic concepts of point kinematics. 2. Motion of a point in a uniform gravitational field. 3. The concept of space velocities. Motion of artificial satellites and planets. 4. Basic issues of kinematics and dynamics of a discrete system of material points. 5. Fundamentals of the molecular kinetic theory of gases. An ideal gas.
Content module 2. " Visualization of mechanical vibrations"
1. The concept of fluctuations. Fluctuations in nature and technology. 2. Free oscillations of a material point. 3. Forced oscillations of the material point. The phenomenon of resonance. 4. Basic concepts of wave theory. 5. Formulation of the problem of string oscillations. 6. Methods of solving the string oscillation problem.

12. Distribution of points received by students

Current and periodic control							Final control (exam)	Total points
Content module 1			Content module 2			Individual independent task		
T1	**T2**	**T3**	**T4**	**T5**	**T6**			
10	**10**	**10**	**10**	**10**	**10**	**-**	**40**	**100**

Evaluation scale: national and ECTS

The sum of points for all types of educational activities	Rating ECTS	Evaluation on a national scale	
		for an exam, course project (work), practice	for credit
90 - 100	**AND**	perfectly	counted
82-89	**IN**	fine	
74-81	**WITH**		
64-73	**D**	satisfactorily	
60-63	**IS**		
35-59	**FX**	unsatisfactory with the possibility of reassembly	not counted with the possibility of retaking
0 - 34	**F**	unsatisfactory with mandatory repeated study of the discipline	not enrolled with mandatory repeated study of the discipline

13. Educational and methodological support

a) work program of the academic discipline;
b) syllabus;
c) a synopsis of lectures on theoretical material;
d) methodical instructions (recommendations) regarding the performance of control tasks;
e) software and methodical support for the execution of tasks.

14. Recommended literature

Basic

1. Andrunyk V.A., Vysotska V.A., Pasichnyk V.V., Chirun L.B., Chirun L.V. Numerical methods in computer sciences: a study guide. Lviv: "New World - 2000", 2020. 470 p.
2. Weisfeld N. D. Equations of mathematical physics: teaching method. manual for students special "Applied mathematics" / N. D. Weisfeld, V. V. Reut. –

Odesa: Odesk. National University named after I. I. Mechnikova, 2018. 194 p.
3. Makhney O.V. Mathematical modeling. Ivano-Frankivsk: V.P. Suprun, 2015. – 372 p.
4. Pavlovsky M.A. Theoretical mechanics. K.: Technika, 2002. 510 p.
5. Theoretical mechanics / V.M. Bulgakov, V.V. Yaremenko, O.M. Chernysh, M.G. Berezovy - K.: Center for Educational Literature, 2019. 705 p.

Auxiliary

1. Karavanova T. P. Fundamentals of algorithmization and programming. 750 problems with recommendations and examples: Kyiv: Forum, 2002. 287 p.
2. Konovalenko I. V., Marushchak P. O., Savkiv V. B. Programming in the C# 7.0 language: a study guide. Ternopil: Ternopil National Technical University named after Ivan Pulyu, 2017. 300 p.
3. Shakhno S. M., Dudykevich A. T., Levytska S. M. Workshop on numerical methods: study guide. Lviv: LNU named after Ivan Franko, 2013. 432 p.