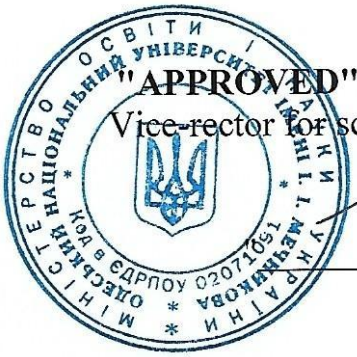
MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
ODESSA I.I. Mechnikov NATIONAL UNIVERSITY
Department of mathematical support of computer systems



"APPROVED"
Vice-rector for scientific and pedagogical work

_____
"_____ 20___

WORKING PROGRAM OF EDUCATIONAL COURSE

VB4 "Still image compression methods"
(course name)

Level of higher education Second (master's)

Field of knowledge 12 – Information technologies

Specialty 126 – Information systems and technologies
(code and name of specialty)

Educational and professional program Information systems and technologies
(EPP/ESP name)

ONU - 2022

The working program of the educational course "Still image compression methods". – Odesa: ONU, 2022. – 8 p.

Developer:
Petrushyna T.I., Ph.D. (Ph.-M.), Associate Professor of the Department of MSCS

The working program was approved at the meeting of the Department of Mathematical Support of Computer Systems

Protocol No. 1 from "25" 08 2022 year

Head of the department _____ (Eugene MALAKHOV)
(signature) (First Name Surname)

Agreed with the guarantor of the EPP "Information systems and technologies"

(signature) (First Name Surname) _____ (Eugene MALAKHOV)

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

Protocol No. 1 from "31" 08 2022 year

Head of EMC _____ (Alla RACHYNSKA)
(signature) (First Name Surname)

Reviewed and approved at the meeting of the department _____

Protocol No. 1 from "29" 08 2023 year

Head of Department _____ (Ye. Malakhov)
(signature) (First Name Surname)

Reviewed and approved at the meeting of the department _____

Protocol No. ___ from "____" _____ 20__ year

Head of Department _____ (_____)
(signature) (First Name Surname)

1. Course description

<table>
<tr><td rowspan="2">Name of indicators</td><td rowspan="2">Field of knowledge, direction of training, educational and qualification level</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="11">The total number of:

credits - 4

hours - 120

content modules - 2</td><td>Branch of knowledge
<u>12 - Information technologies</u>
(code and name)</td><td colspan="2">Optional</td></tr>
<tr><td rowspan="4">Specialty
<u>126 – Information systems and technologies</u></td><td colspan="2">Year of preparation:</td></tr>
<tr><td>1st</td><td></td></tr>
<tr><td colspan="2">Semester</td></tr>
<tr><td>2nd</td><td></td></tr>
<tr><td rowspan="7">Level of higher education:
<u>Second (master's)</u></td><td colspan="2">Lectures</td></tr>
<tr><td>18 hours</td><td>8 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>18 hours</td><td>6 hours</td></tr>
<tr><td colspan="2">Independent work</td></tr>
<tr><td>84 hours</td><td>106 hours</td></tr>
<tr><td colspan="2">Individual tasks:</td></tr>
<tr><td colspan="2">Final control form:
test</td></tr>
</table>

* - in the presence

2. The purpose and tasks of the educational course

The purpose of the course includes the study of the basic concepts and principles of image compression, the study of image compression methods and algorithms and their use in modern archivers.

Task:

– acquisition of system ideas about the mathematical and algorithmic bases of data compression and their application for processing audio and video information;
– familiarization with popular graphic standards and classic algorithms for compression, visualization and archiving of information;
– development of information compression technologies.

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

1) general: -
2) special (professional):

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

SC05. The ability to utilize modern data analysis technologies for optimizing processes in information systems.

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

SCM07. The ability to conduct information analysis and create multi-dimensional models of subject areas.

Program learning outcomes:

LO09. Develop and use data repositories, and perform data analysis to support decision-making.

LOM05. Present research results, conduct discussions and publish research findings.

LOM06. Develop mathematical models and software-information systems to solve current problems of multimedia information analysis and processing.

LOM08. Create optimized pipelines for data preparation for subsequent storage and processing.

Expected learning outcomes. As a result of studying the academic discipline, the student should

***know**: methods and algorithms of information compression and archiving; main directions of development and methods of archiving and storing information; methods of calculating the characteristics and coding of random discrete and continuous systems.*

***be able**: choose the optimal and effective method of information compression, taking into account the specifics of the task; programmatically implement information compression algorithms using programming languages and environments; determine the structure of optimal models and evaluate their quality taking into account compression; use the selected programming environment to develop procedures for integrating software modules.*

3. Course content

Content module 1 Methods of compression of static images without loss.
Тема 1. General concepts and principles of image compression.
Literature: [1, 2, 7].
Тема 2. RLE algorithm. Modifications are possible.
References: [4, 7].
Тема 3. LZW algorithm. Modifications are possible.
Literature: [1, 3].
Тема 4. Huffman's algorithm. Concept of prefix code.
Literature: [1, 2, 6, 8].

Content module 2 Lossy static image compression methods.
Тема 1. Lossy archiving algorithms. Using different measurements.

References: [6, 10].
Тема 2. JPEG algorithm. The essence of DCT. Operations pipeline.

Literature: [1, 6].
Тема 3. Recursive (wave) algorithm.

Literature: [1, 4, 5, 6].

4. Course structure

Names of content modules and topics	Number of hours									
	Full-time					Correspondence form				
	That's all	including				That's all	including			
		l	p	lab	W ed		l	p	lab	Wed
1	2	3	4	5	6	7	8	9	10	11
Content module 1. Methods of compression of static images without loss.										
Topic 1.	3	1			2	2.5	1			2
Topic 2.	10	2		2	6	9	1		0.5	8
Topic 3.	26	4		4	18	22.5	1		1.5	20
Topic 4.	14	2		2	10	17.5	1		1	16
Content module 2. Lossy static image compression methods										
Topic 1.	6	2			4	8.5	1			8
Topic 2.	34	4		6	24	32	2		2	26
Topic 3.	27	3		4	20	28	1		1	26
Hours in general	**120**	**18**		**18**	**84**	**120**	**8**		**6**	**106**

5. Topics of seminar classes

Seminar classes are not provided

6. Topics of practical classes

Practical classes are not provided

7. Topics of laboratory classes

No s/p	Topic name	Number hours	
		Full-time	Correspondence form
1	Development of a UI shell for testing archiver models.	2	
2	Development of the RLE archiver model	2	1
3	Development of the LZW archiver model	4	2
4	Development of the Huffman code archiver model	2	1
5	Development of a JPEG/Wavelet archiver model.	8	2
	Together	**18**	**6**

8. Independent work

No s/p	Topic name	Number hours	
		Full-time	Correspondence form
1	LZW algorithm. Modifications are possible.	8	10
2	Huffman's algorithm and arithmetic coding.	28	36
3	Algorithm JPEG200 Pipeline of operations.	28	34
4	Fractal compression.	20	26
	Together	**84**	**106**

Independent work includes:
[1] – preparation for lectures and laboratory classes;

8.1. Individual educational and research task (course project or calculation and graphic work) is not provided

9. Teaching methods

Lectures using multimedia presentation material.

10. Control methods

During the final control, the student must answer the questions from the list given in point 11.

10.1. Evaluation criteria at the final control:

1. The answer should be complete and short. It should not contain material that does not relate to the essence of the question.
2. Clearly formulate statements, skillfully apply the necessary formulas and knowledge of the main issues of the program.
3. Answers with false statements are evaluated based on the closeness of the answer to the correct one.

4. Omissions in the justification of statements are taken into account and this leads to a decrease in the number of points.
5. Small flaws, inaccuracies in the presentation of the material, reduce the number of points.
6. Ignorance and misunderstanding of the main idea of a theoretical question or problem leads to the withdrawal of up to 90% of points.
7. If there is no answer to the question, zero points are assigned.

11. Questions for the final control

1. Image classes.
2. Application classes.
3. Criteria for comparison of archiving algorithms.
4. Concept of lossless archiving algorithms.
5. Difference between algorithm and format.
6. The principle of construction of the RLE algorithm.
7. The principle of construction of the LZW algorithm.
8. Possible methods of organizing the chain table.
9. Concept of prefix code.
10. Concept and properties of optimal prefix code.
11. Concept of "greedy" algorithms.
12. Proof of the optimality of Huffman's algorithm.
13. The principle of lossy archiving. Loss assessment problems.
14. Use of various measures during lossy archiving
15. Different color rendering systems. The essence of the DCT transformation.
16. Characteristic artifacts of the JPEG algorithm.
17. Recursive (wave) algorithm. The idea of the method. The presence of artifacts.
18. JPEG2000 algorithm. Operations pipeline. Image compression and recovery steps
19. Comparison of the JPEG2000 algorithm with the JPEG algorithm.
20. Fractal algorithm. Barnsley photocopier. The IFS concept.
21. Fixed point theorem.
22. Theorem on compressive transformation.

12. Distribution of points received by students

Current testing and independent work							Final control (exam)	Sum
Content module #1				Content module No. 2				
T1	T2	T3	T4	T1	T2	T3		
10	10	10	10	10	10	15	25	100

T1, T2 ... - topics of content modules.

Evaluation scale: national and ECTS

Total points	ECTS assessment	National scale	
90 - 100	A - "excellent"	5 "excellent"	"test"
85 - 89	B - "very good"	4 "good"	
75 - 84	C - "good"		
70 - 74	D - "satisfactory"	3 "satisfactory"	
60 - 69	E - "permissible"		
35 - 59	F - "unsatisfactory with the possibility of reassembly"	2 "unsatisfactory"	"uncounta
0 - 34	FX – "unsatisfactory with mandatory repeat course"		

13. Educational and methodical support

Synopsis of lectures in electronic format.

14. Recommended Books

14.1. Basic literature

1. Sayood, Kh. Introduction to Data Compression: Morgan Kaufmann, 2017. - 790p.
2. Sayood, K., Memon, N. (2012). Lossless Compression Handbook: Academic Press, 2012 – 488p.
3. Hirschberg, Daniel S. and Campanella, S. Joseph. Data Compression. AccessScience. : McGraw-Hill Education, 2014. - 217p.
4. J. Myano. Image compression formats and algorithms in action. — M.: Izdatelsto Triumf, 2008. — 336 p.
5. D. Salomon. Compression of data, images and sound. — M.: Technosfera, 2009. — 368 p.

14.2. Auxiliary literature

6. June F. An Introduction to 3D Computer Graphics, Stereoscopic Image, and Animation in OpenGL and C/C++ : Create Space, 2011. - 428p.
7. SehrawatP.Data Compression and Decompression using Huffman coding: LAP LAMBERT Academic Publishing, 2019 – 56p.

15. Electronic information resources

8. Axis Communications. An explanation of video compression techniques.- Access mode:http://www.axis.com/files/whitepaper/wp_videocompression_33085_en_0809_lo.pdf
9. Singh, Ravinder. Data Compression. - Access mode:http://www.authorstream.com/Presentation/aSGuest17059-177396-data-compression-science-technology-ppt-powerpoint/