Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of computer technology

INTRODUCTION TO DATA SCIENCE TECHNOLOGY

(Syllabus)

Details of the academic discipline	
Level of higher education	***First (undergraduate)***
Branch of knowledge	*12 Information technologies*
Specialty	*123 Computer engineering,*
Educational program	*Computer systems and networks*
Discipline status	*Elective component of OP*
Form of education	*full-time / part-time*
Year of training, semester	*2nd, 3rd year, autumn, summer*
Scope of the discipline	*4 credits / 120 hours*
Semester control/ control measures	*Test, MCW*
Timetable	*http://rozklad.kpi.ua/*
Language of teaching	*English*
Information about head of the course / teachers	Lecturer:*Doctor of Technical Sciences, Professor Oleksii Oleksandrovich Pisarchuk, agd015979@gmail.com.* Laboratory:*Doctor of Technical Sciences, Professor Oleksii Oleksandrovich Pisarchuk, agd015979@gmail.com.*
Placement of the course	*https://drive.google.com/drive/folders/1xqv2CMJ_BJmOL8QK2GjUne6coi0T5l2U?usp=share_link* *https://classroom.google.com/c/NDIxODIzNTEyNDUy?cjc=qnsxkzd*

Program of educational discipline

1. Description of the educational discipline, its purpose, subject of study and learning outcomes

The discipline "Introduction to Data Science" is designed for students to acquire the ability*synthesize, verify mathematical models, develop specialized software for processing and analyzing data of various types and volumes. This is achieved by studying the theoretical foundations of the synthesis of mathematical models, the methodology of choosing methods, and algorithms for data processing of various types, the verification of the obtained results by simulation modeling methods, as well as the practical implementation of the selected approaches in order to develop specialized application programs.*

The purpose of studying the course*"Introduction to Data Science technology" is: acquisition by students of the ability to synthesize, verify mathematical models, develop specialized software for processing and analyzing data of various types and volumes.*

The course is based on the disciplines of Higher Mathematics; Probability theory and mathematical statistics; Discrete Math; Programming; Data structures and algorithms; Organization of databases; Organization of computational processes.

The course materials will be used to implement practical questions on data research of various types and volumes for specific applied tasks, as well as in the implementation of course design tasks, development of qualification papers, etc.

Discipline is aimed at providing*comprehensive thorough theoretical basis and powerful practical skills of software implementation of methods, mathematical models and algorithms of technological*

processes Data Science (data research): data - information - knowledge - knowledge manipulation - visualization.

Specifics of the course*consists in considering, along with classic Data Science methodologies, advanced author's developments obtained during the implementation of practical R&D projects.*

The theoretical foundations of Data Science are provided in the form of lectures with a mandatory demonstration of the considered algorithms in the form of examples of program code.

Practical skills in the application of Data Science technologies are acquired in laboratory classes. At the same time, special attention is paid to software engineering processes. The practical part of the discipline is focused on the application of the high-level Python programming language with the study of the functionality of the libraries: Pandas, NumPy, Matplotlib, OpenCV, PIL, scikit-learn.

The discipline reveals the essence of Data Science technological processes: data processing for the purpose of obtaining information - information processing for the purpose of discovering knowledge - using skills in practice - visualization of results.

According to the results of studying the course, the student should know:

methods, models and algorithms of applied statistical data analysis, the order of their application and the properties of the results (data models; statistical analysis of the characteristics of the experimental sample; processing of anomalous measurements; evaluation, extrapolation and interpolation by trend models - recurrent smoothing and smoothing of the accumulated sample; construction of nonlinear models of experimental data using differential transformations);

multi-criteria decision-making methods (multi-criteria evaluation; multi-criteria identification; multi-criteria allocation of resources; multi-criteria structural and parametric synthesis of systems;

methods, models and algorithms of intelligent data analysis (technologies: OLAP, Data Mining, Text Mining, Image Mining, Knowledge discovery, Speech and language recognition);

the procedure for applying methods, models and algorithms of artificial intelligence for Data Science technologies (artificial neural networks; multi-criteria optimization neural networks; model methods and algorithms of self-organization and situational analysis);

algorithms and technologies for forecasting the dynamics of changes in financial and stock markets (according to statistical and alternative models);

algorithms and technologies for determining credit risks for banking CRM systems (scoring and multi-criteria models);

algorithms for identifying current situations for production CRM systems and critical infrastructure facilities (multifactor analysis and Computer Vision technologies).

According to the results of studying the course, the student should be able to:

apply methods, models and algorithms of applied statistical data analysis and implement them in the form of application software;

apply multi-criteria decision-making methods and implement them in the form of application software;

apply methods, models and algorithms of intelligent data analysis and implement them in the form of application software;

apply methods, models and algorithms of artificial intelligence for Data Science technologies and implement them in the form of application software;

apply algorithms and technologies for forecasting the dynamics of changes in financial and stock markets and implement them in the form of application software;

apply algorithms and technologies for determining credit risks for banking CRM systems and implement them in the form of application software;

apply algorithms for identifying current situations for production CRM systems and critical infrastructure objects (multifactor analysis and Computer Vision technologies) and implement them in the form of application software.

The result of studying the course is mastering the knowledge, skills and abilities required for the positions: Data Scientist, Data Engineer; Data Analyst – Risk Team, etc.

The course includes*4 credits (120 hours), of which 54 hours are classroom training, 66 hours are independent student work.*

2. **Pre-requisites and post-requisites of the discipline (place in the structural and logical scheme of training according to the relevant educational program)**

Re-requisites:

Basic knowledge of programming, architecture of computer systems and networks, discrete mathematics, computer logic, software engineering processes.

Post-requisites:

121:

ZK01 Ability to abstract thinking, analysis and synthesis;

FK07 Knowledge of information data models, ability to create software for data storage, extraction and processing;

FK14 Ability to algorithmic and logical thinking;

PRN05 Know and apply relevant mathematical concepts, methods of domain, system and object-oriented analysis and mathematical modeling for software development

123:

ZK 1 Ability to abstract thinking, analysis and synthesis.

FC2 Ability to use modern methods and programming languages to develop algorithmic and software.

FC18 The ability to develop, adapt, use software to improve the efficiency of the use of high-performance computer systems

The place of the discipline in the structural and logical scheme of education:

The discipline refers to the selective component of the OP, the professional training cycle. The course is focused on applied aspects of design, synthesis and development of mathematical models, algorithms and software of complex distributed information systems with the properties of intelligence, which is an interdisciplinary connection of the components of the educational program.

3. **Content of the academic discipline**

Chapter 1. Methodological foundations of Data Science.

Section 1.1. Applied statistical data analysis.

Topic 1. Introduction to data analysis.

Topic 2. Statistical analysis of the characteristics of the experimental sample.

Topic 3. Preliminary processing of experimental data. Abnormal measurements.

Topic 4. Algorithms of recurrent and accumulated smoothing.

Topic 5. Nonlinear smoothing of experimental data.

Section 1.2. Multi-criteria decision-making methods.

Topic 6. Methodical bases of decision-making. Multi-criteria decision-making.

Topic 7. Technologies of multi-criteria decision-making.

Section 1.3. Intelligent data analysis.

Topic 8. Methodological foundations of intelligent data analysis.

Topic 9. Technologies of intelligent data analysis.

Section 1.4. Application of artificial intelligence for Data Science technologies.

Topic 11. Technological aspects of artificial intelligence.

Chapter 2 Technological aspects of Data Science.

Section 2.1. Algorithms and technologies for forecasting the dynamics of changes in financial and stock markets.

Topic 12. Methodological foundations of forecasting the dynamics of changes in financial and stock markets:

Topic 13. Technologies for forecasting the dynamics of changes in financial and stock markets.

Section 2.2. Algorithms and technologies for determining credit risks for banking CRM systems.

Topic 14. Methodological bases for determining credit risks for banking CRM systems.

Topic 15. Technologies for determining credit risks for banking CRM systems.

Section 2.3. Algorithms for identification of current situations for production CRM systems and objects of critical infrastructure.

Topic 16. Methodological bases for identifying current situations for production CRM systems and critical infrastructure facilities.

Topic 17. Current situation identification technologies for production CRM systems and critical infrastructure facilities.

4. Educational materials and resources

List of main information sources:

1. Educational and methodological complex of the discipline: Introduction to Data Science technology [https://drive.google.com/drive/folders/1xqv2CMJ_BJmOL8QK2GjUne6coi0T5l2U].

2. E-course on the Sikorsky educational platform "Introduction to Data Science Technology", 2022:https://classroom.google.com/c/NDIxODIzNTEyNDUy?cjc=qnsxkzd

3. Pisarchuk O.O. Nonlinear and multicriteria modeling of processes in motion control systems / O. O. Pisarchuk, V. P. Kharchenko. - Monograph. - K.: Institute of the Gifted Child, 2015. - 248 p.

4. Pisarchuk O.O. Multi-criteria mathematical models of situational management and self-organization in complex information systems / Pisarchuk O.O., Danyk Y.G., Shestakov V.I., Sokolov K.O., and others. - Monograph. – Zhytomyr: PE "Ruta", 2016. – 232 c.

5. Kovbasiuk S.V. The method of least squares and its practical application / S.V. Kovbasiuk, O.O. Pisarchuk, M.Yu. Rakushev // Monograph. - Zhytomyr: ZVI NAU, 2008. - 228 p.

6. Pisarchuk O.O. Monitoring of objects in conditions of a priori uncertainty of information sources. Theory and practice / Yu. Ya. Bobalo, Yu. G. Danyk, O. O. Pisarchuk, L. O. Komarova and others // Monograph. - Lviv: Kolo, 2014. - 235 c.

7. Shmatok S.O. Introduction to the theory of operations research / Shmatok S.O., Danyk Y. G., Pisarchuk O.O. - Monograph. - Zhytomyr: ZhVI, 2015. - 316 c.

8. Pisarchuk O.O. Methodological foundations of scientific research. Mathematical modeling and optimization of complex systems / Grabar I.G., Dannyk Y.G., Pisarchuk O.O., Humenyuk M.O. and other. Tutorial. - Zhytomyr: ZhVI DUT, 2015. - 680 p. (With the seal of the Ministry of Education and Culture of Ukraine. Letter No. 1/11-10150 dated July 2, 2014).

9. Pisarchuk O.O. Basics of the theory of systems and system analysis / O.O. Pisarchuk, M.A. Pavlenko, O.V. Petrov, S.I. Khmelevsky, and others. Textbook - Kharkiv: KhNUPS, 2018. - 215 p.

10. Kovbasiuk S.V. Fundamentals of software and mathematical support of automated military control systems / S.V. Kovbasiuk, O.O. Pisarchuk, S.A. Gergovskyi // Educational manual. - Zhytomyr: ZVIRE, 2005. - 300 p.

11. Kovbasiuk S.V. Software and mathematical support of computing systems of ASU / S.V. Kovbasiuk, O.O. Pisarchuk // Synopsis of lectures. - Zhytomyr: ZVIRE, 2006. - 164 p.

12. Kovbasiuk S.V. Theoretical basis of automation of decision-making processes in management systems / S.V. Kovbasiuk, O.O. Pisarchuk // Educational manual. - Zhytomyr: ZVIRE, 2006. - 132 p.

13. Buchyk S.S. Decision support systems / S.S. Buchyk, O.O. Pisarchuk // Synopsis of lectures. - Zhytomyr: ZVIRE, 2006. - 168 p.

14. Salyuk M.A. Statistical processing of experimental research data. Methodical manual for the course "Experimental psychology" / edited by E.L. Nosenko - Dnipropetrovsk: Innovation, 2010. - 26 p.

15. Marchenko O.O., Rossada T.V. Actual problems of Data Mining: Study guide for students of the Faculty of Computer Science and Cybernetics. - Kyiv. - 2017. - 150 p.

16. Lande D.V., Subach I.Yu., Boyarynova Yu.E. Fundamentals of the theory and practice of intelligent data analysis in the field of cyber security: a study guide. – K.: ISZZI KPI named after Igor Sikorsky", 2018. — 297 p.

17. Vasylenko O. A. Mathematical and statistical methods of analysis in applied research: teaching. manual / O. A. Vasylenko, I. A. Sencha. – Odesa: ONAZ named after O. S. Popova, 2011. – 166 p.

18. Bakhrushin V.E. Methods of data analysis: a study guide for students / V.E. Bakhrushin – Zaporizhzhia: KPU, 2011. – 268 p.

19. Foster Provost and Tom Fawcett. Data Science for Business / Foster Provost and Tom Fawcett. - Printed in the United States of America. Published by O'Reilly Media, Inc, 2013. - 409 p.

20. David Dietrich. Data Science & Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data / David Dietrich, Barry Heller, Beibei Yang. - John Wiley & Sons, Inc., Indianapolis, Indiana, 2015. - 420 p.

List of additional information sources:

1. Bakhrushin V.E. Mathematical modeling / V.E. Bakhrushin - Zaporizhzhia: State University "ZIDMU", 2003. - 138 p.

2. Bakhrushin V.E. Data analysis: study guide / V.E. Bakhrushin – Zaporizhzhia: GU "ZIDMU", 2006. – 128 p.

3. Bakhrushin V.E. Mathematical foundations of system modeling: study guide / V.E. Bakhrushin – Zaporizhzhia: KPU, 2009. – 224 p.

4. Kishan G. Anomaly Detection Principles and Algorithms / Kishan G., Mehrotra, Chilukuri K. Mohan, HuaMing Huang. - Switzerland: Springer, 2017. - 229 p.

5. Hanna Blomquist, Johanna Möller. Anomaly detection with Machine learning. Quality assurance of statistical data in the Aid community, 2015. - 60 p. [https://uu.diva-portal.org/smash/get/diva2:846985/FULLTEXT01.pdf].

6. Srikanth Thutsi, Philip Branch, Jiong Jin and Jugdutt (Jack) Singh. A comprehensive survey of anomaly detection techniques for high dimensional big data. Springer, 2017. – 30 p.

Educational content

5. Methods of mastering an educational discipline (educational component)

Chapter 1. Methodological foundations of Data Science:
Section 1.1. Applied statistical data analysis.
Lecture 1. Introduction to data analysis:
structure and tasks of the discipline;
basic information about Data Science technologies;
technologies of applied statistical analysis;
Data Science technologies in Python.
Lecture 2. Statistical analysis of the characteristics of the experimental sample.
modeling, data models, classes and error models;
statistical analysis of the characteristics of the experimental sample;
simulation modeling and the Monte Carlo method;
technologies of simulation modeling and evaluation of statistical characteristics of experimental samples in Python.
Laboratory work #1. Research of statistical characteristics of experimental data:
law model, measurement model (linear, non-linear), Monte Carlo method, determination of statistical characteristics of an experimental sample.
Lecture 3. Preliminary processing of experimental data. Abnormal measurements:
detection and processing of abnormal measurements;
general information about estimation, extrapolation and interpolation by trend models;
data correlation analysis;
technologies for detection and processing of anomalous measurements in Python.
Lecture 4. Algorithms of recurrent and accumulated smoothing:
recurrent smoothing, Kalman filter;
techniques of recurrent smoothing in Python;
smoothing of the accumulated sample, the method of least squares;
Accumulated Sample Smoothing Techniques in Python.
Laboratory work #2. Research of recurrent smoothing algorithms:
abnormal measurements and their processing;
recurrent smoothing and properties of estimates.
Lecture 5. Nonlinear smoothing of experimental data:
nonlinear problems and the method of differential transformations;
modified nonlinear Kalman filter;

modified nonlinear forms of the least squares method;
non-linear smoothing techniques in Python.
Laboratory work #3. Study of smoothing algorithms by the accumulated sample:
abnormal measurements and their processing;
pooled sample smoothing and estimation properties.
Section 1.2. Multi-criteria decision-making methods.
Lecture 6. Methodological foundations of decision-making. Multi-criteria decision-making:
decision-making theory;
optimization, multi-criteria optimization.
Lecture 7. Technologies of multi-criteria decision-making:
multi-criteria evaluation;
multi-criteria identification;
multi-criteria allocation of resources;
multi-criteria structural and parametric synthesis of systems.
Laboratory work #4. Study of multi-criteria decision-making methods:
multi-criteria evaluation;
multi-criteria identification;
multi-criteria allocation of resources;
multi-criteria structural and parametric synthesis of systems.
Section 1.3. Intelligent data analysis.
Lecture 8. Methodological foundations of intelligent data analysis:
intelligent data analysis - essence, fields of application;
methodological foundations of intelligent data analysis: OLAP, Data Mining, Text Mining, Image Mining, Knowledge discovery, Speech and language recognition.
Lecture 9. Technologies of intelligent data analysis:
technologies of intelligent data analysis in Python (OLAP, Data Mining, Text Mining, Image Mining, Knowledge discovery, Speech and language recognition).
Laboratory work #5. Research of intelligent data analysis technologies:
OLAP, Data Mining, Text Mining, Image Mining, Knowledge discovery, Speech and language recognition.
Section 1.4. Application of artificial intelligence for Data Science technologies.
Lecture 10. Modern information technologies and artificial intelligence:
general information about artificial intelligence. Cognitive informatics;
synergy, model methods and algorithms of self-organization and situational analysis;
technologies for implementing self-organization algorithms in Python.
Lecture 11. Technological aspects of artificial intelligence:
artificial neural networks;
multi-criteria optimization neural networks;
technologies for implementing artificial neural networks in Python.
Laboratory work #6. Study of processes of application of artificial intelligence for data analysis tasks:
artificial neural networks;
multi-criteria optimization neural networks.
Chapter 2 Technological aspects of Data Science:
Section 2.1. Algorithms and technologies for forecasting the dynamics of changes in financial and stock markets.
Lecture 12. Methodological foundations of forecasting the dynamics of changes in financial and stock markets:
a priori definition of the type of model;
statistical analysis and forecasting (polynomial and non-linear);
multi-criteria analysis and forecasting.
Lecture 13. Technologies for forecasting the dynamics of changes in financial and stock markets:

statistical analysis and forecasting technologies in Python;
technologies of multi-criteria analysis and forecasting in Python.
Laboratory work #7. Research on methods of forecasting the dynamics of changes in financial and stock markets:
a priori definition of the type of model;
statistical analysis and forecasting (polynomial and non-linear);
multi-criteria analysis and forecasting.
Section 2.2. Algorithms and technologies for determining credit risks for banking CRM systems.
Lecture 14. Methodological basis for determining credit risks for banking CRM systems:
scoring models;
multicriteria models.
Lecture 15. Technologies for determining credit risks for banking CRM systems:
scoring technologies in Python;
multi-criteria analysis techniques for risk assessment in Python.
Laboratory work #8. Research on the technology of determining credit risks for banking CRM systems:
scoring models;
multicriteria models.
Section 2.3. Algorithms for identification of current situations for production CRM systems and objects of critical infrastructure.
Lecture 16. Methodological basis for identification of current situations for production CRM systems and critical infrastructure facilities:
methods and models of pattern recognition theory;
methods and models of multi-criteria identification.
Lecture 17. Current situation identification technologies for production CRM systems and critical infrastructure facilities:
identification technologies for Computer Vision tasks in Python;
technologies for multi-criteria identification of controlled situations on critical infrastructure objects in Python.
Laboratory work #9. Study of algorithms for identification of current situations for production CRM systems and critical infrastructure objects:
identification technologies for Computer Vision tasks;
technologies for multi-criteria identification of controlled situations at critical infrastructure facilities.

6. Independent work of a student/graduate student

As a student's independent work, preparation for classroom classes, calculations based on primary data obtained in laboratory classes, problem solving, and execution of modular control work are used. The total amount of time allocated to independent work is 66 hours.

Policy and control

7. Policy of academic discipline (educational component)

In the process of studying the academic discipline, the following is welcomed and encouraged:
- *collegiality of relationships in the process of implementing the educational process;*
- *timeliness of reporting on all forms of control;*
- *observance of norms of academic integrity.*

The procedure for filing and providing reports on all forms and the procedure for evaluating results is regulated by the procedure specified in the tasks: for laboratory work; modular control work; methodical materials for the calculation.

8. Types of control and rating system for evaluating learning outcomes (RSO)

The evaluation system is a modular rating on a 100-point scale. The student's rating in the discipline consists of points obtained for the following:

1. Attending educational classes.

2. Execution and defense of 9 laboratory works.

3. Execution of 1 MKW.

System of rating (weighted) points and evaluation criteria

Reporting	Lr1	Lr2	Lr3	Lr4	Lr5	Lr6	Lr7	Lr8	Lr9	MKW		The result	Test	Rating
High level of Lr.	10	10	10	10	10	10	10	10	10	10		100	0	100
The average level of Lr.	8	8	8	8	8	8	8	8	8	10		82	18	100
Test	18													

1. Execution and defense of 9 laboratory works

*The weighted point for one work is a maximum of 8. The maximum number of points for all laboratory works is equal to 8 points * 9 = 72 points.*

1.1. Neat preparation of the protocol of laboratory work - 1 point.

1.2. Timely protection of work - 1 point.

1.3. Complete work - 5 points.

1.4. Theoretical preparation for performing laboratory work is assessed by answering one control question - 1 point.

1.5. Practical performance of laboratory work is assessed by answering one control question - 1 point.

1.6. The analysis of the obtained results of laboratory work is evaluated by answering one control question - 1 point.

2. MKW

The maximum number of points for MKW is 10 points.

Students who have scored the required number of points and agree with it can be exempted from credit with attestation according to the current rating.

Table of correspondence of rating points to grades on the university scale:

Scores	Rating
100-95	Perfectly
94-85	Very well
84-75	Okay
74-65	Satisfactorily
64-60	Enough
Less than 60	Unsatisfactorily
Admission conditions not met	Not allowed

9. Additional information on the discipline (educational component)

The list of questions submitted for semester control

List of theoretical questions.

1. Monte Carlo method. Essence and implementation.

2. Models of experimental data.

3. Models of random distribution laws of random variables.

4. Statistical characteristics of random variables and the order of their determination.

5. The essence and procedure of determining the statistical characteristics of parametric data redundancy.

6. The essence and procedure of determining statistical characteristics of temporal redundancy of data.

7. Abnormal measurements. The essence and procedure of detection.

8. Algorithms of recurrent smoothing.

9. The essence of smoothing the accumulated sample. Estimation, interpolation and extrapolation.

10. The essence of decision-making problems.

11. Methods of solving decision-making problems.

12. Multi-criteria problems and methods of their solution.

13. The principle and the Pareto area.

14. Convolution according to a non-linear trade-off scheme. The essence and procedure of application.

15. Multi-criteria synthesis.

16. Multi-criteria evaluation.

17. Multi-criteria identification.

18. Multi-criteria allocation of resources.

19. Intelligent data analysis. Principles, tasks and field of application.

20. OLAP technologies.

21. OLAP cube and its properties.

22. Operations on the OLAP cube.

23. Technologies of OLAP analysis in Python.

24. Data Mining Technologies.

25. Text Mining Technologies.

26. Mathematical methods of Data Mining.

27. The k-means algorithm.

28. The nearest neighbor algorithm.

29. Method of support vectors.

30. The concept of artificial intelligence and cognitive informatics.

31. Mathematical methods of artificial intelligence.

32. The essence of synergy and self-organization.

33. The essence of situationality.

34. Examples of problems in the application of artificial intelligence technologies.

35. Artificial neural networks, basic principles and applications.

36. Python technologies for the implementation of artificial neural networks.

37. Describe the scoring analysis.

38. Mathematical model of scoring analysis.

39. Stages of scoring analysis.

40. Mathematical scoring model.

41. Stages of the loan life cycle from the point of view of scoring analysis.

42. Mathematical methods used for scoring analysis.

43. The method of support vectors, nearest neighbor, neural networks, multi-criteria evaluation.

44. Basic definitions of digital image processing: image; digital processing; digital image processing technology.

45. Stages of digital image processing.

46. Describe the stage of image improvement.

47. Describe the image segmentation stage.

48. Image segmentation. Essence and implementation.

49. Algorithms for improving digital images.

50. Basic algorithms for filtering digital images.

List of practical questions.

1. Form a model of the normal law and determine the statistical characteristics of the sample.

2. Form a measurement model according to the quadratic law with the normal law of error.

3. Form a measurement model according to a periodic law with a normal error law.

4. Form a measurement model according to the quadratic law with the normal law of error and the uniform law of anomalous measurements.

5. Implement a script with recurrent smoothing of a sample of dimensions.

6. Implement a script with smoothing of a sample of measurements using the method of least squares.

7. Implement a script with the definition of an integrated assessment of the effectiveness of 10 products according to 3 indicators of effectiveness.

8. Implement a script to determine the frequency of occurrence of words in the text and build a frequency histogram.

9. Implement a script with the definition of an integrated evaluation of the effectiveness of 9 products according to 5 performance indicators.

10. Using tools for digital processing of graphic images, Python and the OpenCV library, develop scripts that implement the formation of a monochrome image from a color one and filter the image using the selected method. Choose the image yourself.

11. Using tools for digital processing of graphic images, Python and the OpenCV library, develop scripts that implement the formation of shades of gray from a color image and image filtering by the selected method. Choose the image yourself.

12. Using tools for digital processing of graphic images, Python and the OpenCV library, develop scripts that implement the formation of an inverse image from color and image filtering by the chosen method. Choose the image yourself.

Working program of the academic discipline (syllabus):

Compiled by Oleksiy Oleksandrovich Pisarchuk, professor of the Department of Computer Science, Doctor of Technical Sciences.

Approved by the Department of Computing (Protocol No. 10 dated 05/25/2022).

Agreed by the Methodical Commission of the Faculty of Informatics and Computer Engineering (protocol No. 10 dated 06/09/2022).