Ministry of Education and Science of Ukraine
Ivano-Frankivsk National Technical University of Oil and Gas
Institute of Information Technologies
the name of the institute of the graduation department

APPROVED
Head of IT institute_____
(name of the institute)
_____
(signature) (First Name Surname)

"___" _____ 20_____.

Syllabus

_____Principles and methods of data analysis in energy industry_____

(name of academic discipline)

Educational level _____**master**_____
(name of educational level)

Branch of knowledge _____**17 - Electronics, automation and electronic communications**_____
(code and name of field of knowledge)

Specialty_____**175 - Information measurement technologies**_____
(code and name of specialty)

Specialization_____
(name of specialization, if available)

Educational program _____**"Information technologies for sustainable energy engineering"**_____
(name of EP)

Discipline status _____**mandatory**_____
mandatory/optional

Language of teaching _____**English**_____

2023

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Approved at the meeting of the Computer systems and networks department

Protocol No. ____, dated "___"_____ 20___.

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1 GENERAL INFORMATION ABOUT THE EDUCATIONAL DISCIPLINE

The purpose and tasks of the discipline	*The module "Principles and methods of data analysis in energy industry" aims to teach applicants how to apply techniques of data collection methods, data preprocessing and data analysis techniques to energy-related data, such as energy consumption data, renewable energy generation data, or energy price data. By the end of the module, students will have the skills needed to collect, preprocess, analyse, and interpret energy-related data, and use this information to make informed decisions in the energy sector.* *The aims of the "Principles and methods of data analysis in energy industry" module are to:* *- Develop an understanding of the principles and methods of data analysis in the energy industry* *- Develop practical skills in data analysis.* *- Develop knowledge of energy-related data sources such as energy consumption data, renewable energy generation data, or energy price data.* *- Develop critical thinking skills: evaluate the quality and reliability of energy-related data, and how to use data to identify trends, patterns, and anomalies in the energy sector.*
Link to place the discipline on the educational platform	*https://dn.nung.edu.ua/course/view.php?id=1664*
Prerequisites for studying the discipline / prerequisites	-
Post-requisites	*Computer simulation and design of experiment* *Design and development of information systems for energy industry control and monitoring*
Learning outcomes	*PR01. Know and understand modern methods of scientific research, organisation and planning of an experiment, computerised methods of research and processing of measurement results.* *PR02. Know and understand the basic concepts of the theory of measurements, apply them in practice and in computer modelling of objects and phenomena.* *PR04. Be able to perform analysis of engineering products, processes and systems according to established criteria, choose and apply the most suitable analytical, calculation and experimental methods for conducting research, interpret research results.* *PR05. Be able to formulate and solve tasks in the field of metrology related to the procedures of object observation, measurement, control, diagnosis and forecasting, taking into account the importance of social constraints*

	(society, health and safety, environmental protection, economy, industry, etc.). *PR08. To have modern methods and techniques of design and research, as well as analysis of the obtained results.* *PR13. Apply hardware and software tools of modern information technologies to solve problems in the field of metrology and information measuring technology.* *PR15. Be able to use computerised databases, "cloud" and Internet technologies, scientific databases and other relevant sources of information*
Competences	*General:* *K03. Information and communication technologies skills.* *K07. Ability to make informed decisions.* *Professional* *K11. Ability to choose and apply suitable mathematical methods, computer technologies, as well as approaches to standardization and certification for solving tasks in the field of competence of metrology and information-measuring technology.* *K13. Knowledge and understanding of scientific facts, concepts, theories, principles and methods of experimental informatics.* *K19. Ability to develop software, hardware and metrological support of computerized information measurement systems.*
Final control, form	*Credit, Course paper*
List of social, "soft" skills (soft skills)	*The discipline "Principles and methods of data analysis in energy industry" can contribute to the development of various soft-skills, including:* *- Critical Thinking: Analysing energy data often involves making sense of complex information and drawing meaningful insights. This process enhances your critical thinking skills, allowing you to evaluate data, identify trends, and make informed decisions.* *- Problem Solving: Data analysis in the energy industry often revolves around addressing challenges related to efficiency, resource allocation, and environmental impact. Engaging with real-world energy data helps you develop effective problem-solving techniques.* *- Statistical Literacy: Understanding statistical concepts is crucial for proper data analysis. You'll gain the ability to interpret and apply statistical methods, which can be valuable in many fields.* *- Data Visualization: Presenting data in meaningful and visually appealing ways is a skill that enhances your ability to convey insights to others. Effective data visualisation supports clearer communication of findings.*

2 EDUCATIONAL DISCIPLINE POLICY

1) regarding attendance at classes and behaviour at them

The attendance of classes and the behaviour of students during classes are regulated by the current regulation "On the organisation of the educational process of IFNTUOG", the Code of Ethics of IFNTUOG, as well as the orders of the Rector of IFNTUOG regarding changes in the organisation of the educational process.

During lectures, the use of mobile phones, laptops and tablets is allowed for viewing presentation and text components of lecture materials. During laboratory classes, it is allowed to use phones and tablets for viewing presentation materials, as well as own laptops for performing laboratory work and demonstrating the results of work during the defence.

Attendance does not have a direct impact on the scoring system, however, in case of systematic absences from classes and non-fulfillment of the prescribed assessed activities (testing, laboratory works, course paper), the teacher reserves the right to report this case to the directorate of the institute in writing.

In the case of conducting classes using e-learning tools, access to the video meetings is carried out exclusively from the corporate email account for the purpose of identifying the student of higher education. If the defence of laboratory work is conducted using e-learning tools, the student must turn on the video connection during the defence of the work report.

2) regarding compliance with the principles of academic integrity

Adherence to the principles of academic integrity during classes is regulated by the current regulation "On academic integrity of employees and students of higher education of IFNTUOG" and the Code of Ethics of IFNTUOG.

During the laboratory work, it is allowed to use fragments of the source code of the program from open sources (forums, code generators based on artificial intelligence, etc.). The source code of the program is not the object of the plagiarism check, although the originality and non-triviality of the solution may positively affect the evaluation.

3) regarding evaluation

The evaluation policy is regulated by the regulation "On the organisation of the educational process at IFNTUOG" and the regulation "On the organisation of current, semester control and attestation of students of higher education with the use of e-learning technologies."

In order to be admitted to the semester control, at the time of completion of the classroom study (before the beginning of the examination session), the student must complete all the laboratory works and pass all the test controls listed in this syllabus. If this requirement is not met, the student will not be admitted to the final examination.

Component evaluations of laboratory work may include an input test control, and must also include an evaluation for the report and for the defence of the laboratory work. The grade for the report is no more than 50% of the total maximum grade for the laboratory work and is a mandatory condition for the laboratory work to be counted as completed.

4) regarding deadlines and rescheduling

The deadlines for the performance of the evaluated activities provided for in the process of studying the discipline are regulated by the schedule of the educational process of the IFNTUOG for the current academic year and are determined by the deadlines for the completion of classroom training. At the end of classroom training (before the beginning of the examination session), the student must complete all laboratory tests and pass all test controls provided for in this work program. If this requirement is not met, the student will not be admitted to the final examination.

To complete and redo the final control, the student must complete the laboratory tests and pass the test control, obtaining the minimum total score, which is regulated by the current regulatory documentation of the IFNTUOG.

5) regarding the recognition of the results of training in non-formal education (if such an opportunity exists)

Non-formal learning outcomes can be recognized and re-credited as part of assessed activities,PROVISIONS about the procedure for recognizing the results obtained in non-formal and

informal education at IFNTUOG (https://docs.google.com/document/d/1ugtRgE4cDqvk41-_NzMm4lce7r1rvVF2qy8ZGcmt9dI/edit) in case of presentation of a certificate of successful completion of the course (with the specified grade) and in case the topics of the online course, training, course correspond to the educational elements of the discipline. Examples of courses whose elements can be recognized and counted as graded activities:
https://www.edx.org/learn/data-analysis

Unified information

6) regarding contesting the results of control measures

Applicants of higher education have the right to appeal the evaluation of the discipline obtained during control measures. The appeal is carried out in accordance with the Regulation on appeals by applicants of higher education on issues related to the educational process, approved by the order of the rector of the university No. 43 of 24.02.2020. You can familiarise yourself with the document by link https://griml.com/L3VUV.	

7) regarding conflict situations

Communication between the participants of the educational process (teachers, students) takes place on the basis of partnership relations, mutual support, mutual respect, tolerance and respect for each person's personality, and is aimed at acquiring true knowledge. The resolution of conflict situations is carried out in accordance with the Regulation on the resolution of conflict situations in IFNTUOG, approved by the order of the rector of the university No. 44 dated February 24, 2020. You can familiarise yourself with the document by link https://griml.com/i42PI.	

8) regarding the student surveys

After completing the course, the applicant is given the opportunity to take a survey regarding the quality of teaching the discipline by link https://nung.edu.ua/department/yakist-osviti/04-anketuvannya	

3 PROGRAM AND STRUCTURE OF THE EDUCATIONAL DISCIPLINE

3.1 Scope of the academic discipline

Table 1 characterises the resource of hours for studying the discipline "Principles and methods of data analysis in energy industry" according to the current learning plan, the distribution by semesters and types of educational work.

Table 1 - Distribution of hours allocated to the study of the discipline

Name of indicators	Total	Distribution by semesters	
		Semester 1	Semester_____
Number of ECTS credits	5	5	
Total amount of time, hours	150	150	
Classroom classes, hours, including:	36	36	
- lecture classes	18	18	
– practical/seminar classes	-	-	
- laboratory classes	18	18	
Independent work, hours	114	114	
Semester control form (examination, assessment, defence of KR, defence of KP)	Course Paper, Credit	Course Paper, Credit	

3.2. Lecture classes

Table 2 characterises the thematic plan of lectures of the discipline.

Table 2 – Thematic plan of lectures

Code	Names of modules (M), content modules (CM), topics (T) and their content	Number of hours	literature
CM1	**Principles and methods of data analysis in energy industry**	**18**	1
T1	Exploratory data analysis	2	
T2	Data Distributions, Probability mass functions	2	
T3	Cumulative distribution functions, Probability density functions	2	
T4	Modelling distributions	2	
T5	Relationships between variables	2	
T6	Hypothesis testing	2	
T7	Linear least squares	2	
T8	Regression	2	
T9	Time series analysis and Survival analysis	2	
	Total hours	18	

3.3. Practical (seminar) classes

Practical (seminar) classes are not provided.

3.4. Laboratory classes

Topics of laboratory classes (list of laboratory works) of the discipline are listed in Table 3.

Table 3 – Topics of laboratory classes

Code	Names of modules (M), content modules (3M), topics of laboratory classes	Number of hours	literature
CM1	**Principles and methods of data analysis in energy industry**	**18**	2
L1	Python basics for data analysis	2	
L2	Distributions and probability functions analysis	2	
L3	Modelling distributions	2	
L4	Probability density functions	2	
L5	Relationships between variables	2	
T6	Hypothesis testing	2	
T7	Linear least squares	2	
T8	Regression	2	
T9	Time series analysis and Survival analysis	2	
	Total hours	18	

3.5. Tasks for self-learning work of the student

Types of independent work within this course are listed in Table 4.

Table 4 – Types of independent work

Names of types of independent work	Number of hours
Studying the material presented at the lectures	18
Preparation for laboratory classes and control measures	18
Preparation of laboratory reports	18
Studying material for independent study	30
Preparing course paper	30
Total hours	114

The list of material submitted for independent study is given in Table 4.

Table 5 - Material presented for independent study

Codes	Names of modules (M), content modules (CM), questions submitted for independent study	Number of hours	literature
CM1	**Principles and methods of data analysis in energy industry**	30	1
T1	Data filtering	10	
T2	Data compression	10	
T3	Data sampling	10	
	Total hours	30	

Control over the processing of topics assigned to independent study is included in the current assessment of the relevant content modules.

3.6. Tasks for course paper

Tasks and schedule for course paper are provided in VLE course.

4. EDUCATIONAL AND METHODOLOGICAL PROVISION OF THE DISCIPLINE

4.1. Core literature

1. Allen B.Downey (2018). Think stats - Green Tea Press.
2. Taieb, D. (2018) Data Analysis with Python: A Modern Approach. Birmingham: Packt Publishing, Limited.
3. McKinney, W. (2022) Python for data analysis : data wrangling with pandas, NumPy, and Jupyter. Third edition. Cambridge: O'Reilly.

4.2. Optional literature

1. Krioukov, Andrew & Goebel, Christoph & Alspaugh, Sara & Chen, Yanpei & Culler, David & Katz, Randy. (2011). Integrating Renewable Energy Using Data Analytics Systems: Challenges and Opportunities. IEEE Data Eng. Bull.. 34. 3-11.
2. Reddy, T. A. (2011). Applied Data Analysis and Modeling for Energy Engineers and Scientists.

4.3. Information resources on the Internet*(if necessary)*

1. *Energy analysis data and tools https://www.nrel.gov/analysis/data-tools.html*
2. *Energy data books https://www.nrel.gov/analysis/energy-data-books.html*
3. *VLE Course https://dn.nung.edu.ua/course/view.php?id=1664*

5. FORMS AND METHODS OF TEACHING AND ASSESSMENT

Forms and methods of training and assessment within the scope of this course are listed in Table 5.

Table 5 – Provision of program learning outcomes in appropriate forms and methods

Cipher of the program learning result	Teaching methods (TM)	Forms and methods of assessment (MFI)
PR01. Know and understand modern methods of scientific research, organisation and planning of an experiment, computerised methods of research and processing of measurement results.	**TM** *1.1 - lecture* **TM** *1.2 – story-explanation* **TM** *2.1 - illustration* **TM** *2.2 - demonstration* **TM** *2.4 - computer and multimedia methods* **TM** *5 - deductive* **TM** *7 - analytical*	*MFO 2 - credit* *MFO 5 - oral control* *MFO 7 - laboratory-practical control* *MFO 8 - test control*

PR02. Know and understand the basic concepts of the theory of measurements, apply them in practice and in computer modelling of objects and phenomena. *PR04. Be able to perform analysis of engineering products, processes and systems according to established criteria, choose and apply the most suitable analytical, calculation and experimental methods for conducting research, interpret research results.* *PR05. Be able to formulate and solve tasks in the field of metrology related to the procedures of object observation, measurement, control, diagnosis and forecasting, taking into account the importance of social constraints (society, health and safety, environmental protection, economy, industry, etc.).* *PR08. To have modern methods and techniques of design and research, as well as analysis of the obtained results.* *PR13. Apply hardware and software tools of modern information technologies to solve problems in the field of metrology and information measuring technology.* *PR15. Be able to use computerised databases, "cloud" and Internet technologies, scientific databases and other relevant sources of information*	**TM** *8 - synthetic* **TM** *15 - problem-searching* **TM** *18 - methods of independent work at home*	

6. CONTROL METHODS AND SUMMATIVE ASSESSMENT STRUCTURE

The distribution of points that students of education can receive based on the results of each type of current and final controls, is provided in the table 6

Table 6 - Distribution of evaluation points

Types of controlled works	Maximum number of points
Laboratory works (9 works for 8 points each). Assessment components of each laboratory work: Report on the performance of laboratory work: 4 points Entrance control: 2 points (4 questions of 0.5 points each) Defense: 2 points	72
Test control (20 closed test questions, duration of test control — 20 minutes)	28
Total points	100

To determine the degree of mastery of the educational material with its subsequent evaluation, the levels of educational achievements of higher education applicants, given in Table 7, are used.

Table 7 - Levels of educational achievements

Levels of educational achievements	Percentage of points for completing tasks	Criteria for evaluating educational achievements	
		Theoretical training	Practical training
		Graduate of higher education	
Distinctive	*90…100*	is fluent in educational material, expresses his opinions, draws reasoned conclusions, reviews the answers of other students, creatively performs individual and collective tasks; independently finds additional information and uses it to implement the tasks set before him; freely uses new information technologies to supplement his own knowledge	can reasonedly choose a rational way of performing the task and evaluate the results of his own practical activity; performs tasks not provided for in the curriculum; freely uses knowledge to solve the tasks set before him
Good	75…89	is fluent in educational material, applies knowledge in practice; summarizes and systematizes educational information, but allows minor shortcomings in comparisons, formulation of conclusions, application of theoretical knowledge in practice	according to the sample, independently performs practical tasks provided by the program; has stable task performance skills
Satisfactory	60…74	knows the educational material superficially, fragmentarily, at the level of memorization reproduces a certain part of the educational material with elements of logical connections, knows the basic concepts of the educational material	has elementary, unstable task performance skills
Unsatisfactory	less than 60	has fragmentary knowledge (less than half) in an insignificant total amount of educational material; lack of formed skills and abilities; significant mistakes are made during the answer	plans and performs part of the task with the help of the teacher

The results of training in the discipline are evaluated on a 100-point scale (from 1 to 100) with conversion to a rating on a traditional scale ("excellent", "good", "satisfactory", "unsatisfactory" according to the scale shown in Table 8).

Table 8 - Grading scale: national and ECTS

National	University (in points)	ECTS	Definition of ECTS
Perfectly	90-100	A	**Perfectly** – excellent performance with only a small number of errors
Good	82-89	B	**Very good** – above average level with few errors
	75-81	C	**Good** - generally correct work with a certain number of gross errors
Satisfactorily	67-74	D	**Satisfactorily**- not bad, but with a significant number of shortcomings
	50-66	E	**Sufficient** – performance meets the minimum criteria
Fail	35-49	FX	**Fail** - you need to work before you can get a credit or pass an exam
	0-34	F	**Fail** - serious further work is needed

7. TEACHING TOOLS

To carry out laboratory work in the discipline "Principles and methods of data analysis in energy industry", a workplace with a PC or laptop must be provided, on which an operating system is installed that supports the installation of Python and modern browsers. All specified software products are freely distributed and can be obtained from the links provided in the laboratory workshop and the e-learning course.