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

Department of automation
electrical engineering and
mechatronic complexes

Virtual instruments of engineering research
Working program of the academic discipline (Syllabus)

Details of the academic discipline

Level of higher education	*Second (master's)*
Branch of knowledge	*14 – Electrical engineering*
Specialty	141 - Power engineering, electrical engineering and electromechanics
Educational program	*Engineering of intelligent electrotechnical and mechatronic complexes*
Discipline status	Normative
Form of education	Eye/distance/mixed
Year of training, semester	*1 year, 1 autumn semester*
Scope of the discipline	*5 ECTS credits (150 hours)*
Semester control/ control measures	*Test, Module test, Calculation and graphic work*
Lessons schedule	*http://roz.kpi.ua/*
Language of teaching	*Ukrainian*
Information about head of the course / teachers	*Lecturer: Doctor of Technical Sciences, Professor, Stefan Volodymyrovych Zaichenko, tel. 067-165-37-48, email: zstefv@gmail.com[1]*
Placement of the course	Available on the Google Classroom platform. The access code is provided by the teacher at the first lesson

Program of educational discipline

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

The main goal of teaching the discipline "Virtual instruments of engineering calculations" is the formation of students' basic knowledge of the basic principles of modeling and research issues of the theory of functioning, computer modeling, design and operation of electrical equipment. Development and use of virtual devices, in the absence of real devices for research.

subject the study of the discipline is the process of optimal functioning of electrical equipment, energy analysis, regulation and optimization of work modes in accordance with actual operating conditions.

Program learning outcomes:

Competencies: (K12) the ability to develop and implement measures to increase reliability, efficiency and safety in the design and operation of equipment and objects of the power industry, electrical engineering and electromechanics; (K14) the ability to demonstrate knowledge and understanding of mathematical principles and methods necessary for use in electric power, electrical engineering and electromechanics; (K19) ability to use software for computer modeling, automated design, automated production and automated development or construction of elements of electric power, electrotechnical and electromechanical systems; (K22) the ability to develop means, methods and methods of science and

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[1] E-mail of the teacher afor other contacts for feedback, it is possible to indicate reception hours or hours for communication in case of specifying contact telephone numbers. For the syllabus of a discipline taught by many teachers (for example, history, philosophy, etc.), you can refer to the site page where the contact information of teachers for the relevant groups, faculties, institutes is presented.

technology aimed at automating existing and creating new automated and automatic technologies and productions.

Ability: (PR01) to reproduce processes in electric power, electrotechnical and electromechanical systems during their computer simulation; (PR03) analyze processes in electric power, electrotechnical and electromechanical equipment and corresponding complexes and systems; (PR05) to master the methods of mathematical and physical modeling of objects and processes in electric power, electrotechnical and electromechanical systems; (PR07) to plan and carry out scientific research and innovative projects in the field of electric power, electrical engineering and electromechanics; (PR15) perform physical and mathematical modeling, static and dynamic analyzes of structures, mechanisms, materials and processes at the design stage, investigate the reliability of systems, with the use of modern computer tools; (PR16) to select the element base of electromechanical and mechatronic systems, complete electric and hydraulic drives, means of control, protection, automation of power supply systems of machines and installations, production sites and enterprises; (PR18) calculate forces, stress-strain state, speeds, moments, power, static and dynamic properties of electromechanical equipment, perform force and hydraulic calculations of elements of hydraulic drives, electric drives, linear and non-linear elements, electric and magnetic circuits.

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

The study of the discipline is based on bachelor's level courses in Technical Mechanics, Hydraulics and Hydraulic Drive, General Physics, Electric Drive, Automation of Technological Processes, Nonlinear Problems and Identification of Mechatronic Systems, Control Systems in Electromechanics. The skills acquired during the course are used in the preparation of a master's thesis.

3. Content of the academic discipline

Chapter 1. Introduction to the subject.
Topic 1.1. Methodology of studying the discipline.
Topic 1.2. An overview of world programs of higher education, regarding the use of virtual devices in engineering.
Chapter 2. Introduction to the LabView environment
Topic 2.1.LabVIEW virtual instrument development environment and its advantages
Topic 2.2. The main components of the virtual device
Topic 2.3. Toolbars Tools Palette, Controls and Functions
Topic 2.4. Context menu of block diagram and front panel objects.
Chapter 3. Instrument control in LabView.
Topic 3.1. Connecting the PC to the "outside world"
Topic 3.2.Classification of signals
Topic 3.3.Signal formation and transformation
Topic 3.4. Measuring schemes
Topic 3.5. Instrument control in LabVIEW

4. Educational materials and resources

Basic literature
1. Kodosky J. LabVIEW //Proceedings of the ACM on Programming Languages. – 2020. – T. 4. – №. HOPL. – C. 1-54.
2. de Asmundis R. (ed.). LabVIEW: A Flexible Environment for Modeling and Daily Laboratory Use. – BoD–Books on Demand, 2021.
3. Stratoudakis T. Introduction to LabVIEW FPGA for RF, Radar, and Electronic Warfare Applications. – Artech House, 2021.

Additional literature

1. Jerome J. Virtual instrumentation using LabVIEW. – PHI Learning Pvt. Ltd., 2010.

Educational content

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

Active learning strategies are applied, which are determined by the following methods and technologies: problem-based learning methods (research method); person-oriented technologies based on such forms and methods of learning as visualization and information and communication technologies, in particular electronic presentations for lectures. Laboratory and practical tests are divided into groups (teamwork). When performing calculation work, the problem-search method, work with literature is used. Communication with the teacher is built using the "Electronic Campus" information system, the "Sikorsky" distance learning platform based on G Suite for Education, as well as such communication tools as e-mail and Telegram.

Lecture classes

No. z/p	The name of the topic of the lecture and a list of main questions
1	**Lecture 1**. Introduction to the subject Methodology of studying the discipline. An overview of world programs of higher education, regarding the use of virtual devices in engineering. ***Didactic tools:***PC, multiplayer, computer lectures WIER. *educational tables of parameters and their measurement units.* ***Recommended Books:****[1] pages 3-6.*
2	**Lecture 2.The LabVIEW shell.Introduction** LabVIEW virtual instrument development environment and its advantages**.** ***Didactic tools:*** PC, multiplayer, computer lectures WIER ***Recommended Books:****[1] p. 7-18.*
3	**Lecture 3. LabVIEW Tool, Control palettes** The main components of the virtual device ***Didactic tools:*** PC, multiplayer, computer lectures WIER ***Recommended Books:****[2] p. 10-22.*
4	**Lecture 4.LabView palette Functions - Functions** Toolbars Tools Palette, Controls and Functions. Context menu of block diagram and front panel objects. ***Didactic tools:***PC, multiplayer, computer lectures WIER ***Recommended Books:****[3] p. 23-26.*
5	**Lecture No. 5**. Creating a virtual device - VI Instrument control in LabView. Connecting the PC to the "outside world". ***Didactic tools:***PC, multiplayer, computer lectures WIER ***Recommended Books:****[1] p. 27-28.*
6	**Lecture 6. Creating a sub-device -SubVI** What is SubVi.?Creating a sub-device – SubVI. Creating a sub-device icon. Changing the icon of SubVi Voltage Read.vi. Subdevice creation algorithm - SubVi Temperature Status.vi. ***Didactic tools:***PC, multiplayer, computer lectures WIER ***Recommended Books:****[1] p. 28-29.*
7	**Lecture 7. Preparation Connector window**- Connector panel Connector window - Connector panel. Conversion of individual parts of virtual devices into sub-devices. Temperature Status.vi virtual instrument. ***Didactic tools:***PC, multiplayer, computer lectures WIER ***Recommended Books:****[4] p. 20-36.*

8	**Lecture 8. Debugging a virtual device** Searching for scheme errors. Tracingschemes Step-by-step execution of the program. *Didactic tools:*PC, multiplayer, computer lectures WIER *Recommended Books:[2] p. 12-33.*
9	**Lecture 9. Assembling a virtual temperature measuring device** Obtaining probe readings.Control points of the scheme. Algorithm for setting up a virtual device. *Didactic tools:*PC, multiplayer, computer lectures WIER *Recommended Books:[1] p. 45-48.*

Practical training

The main tasks of the cycle of practical classes are devoted to the formation of competences in the calculation and selection of electric power, electrotechnical and mechatronic complexes and the measurement of their operating parameters

Practical lesson 1	Introductory lesson. Safety equipment when working with electrical networks. Familiarity with the LabVIEW software product.
Practical lesson 2	Development of a virtual device for temperature conversion from the Celsius scale to the Fahrenheit, Kelvin, Reomur, Rankine scale
Practical lesson 3	Construction of a virtual automated control system for graphs of dependencies during the experiment
Practical lesson 4	Creation of Control and Functional panels of the virtual device Random - Generator of random numbers
Practical lesson 5	Development of Control and Functional panels of a virtual device for solving the Fick (diffusion) equations
Practical lesson 6	Construction of a virtual automated system for performing signal switching functions
Practical lesson 7	Creation of a virtual automated mechatronic complex "Robot manipulator"
Practical class 8	Construction and adjustment of a virtual device for reproducing the oscillation system (Bessel's equation). Frequency level filtering.
Practical lesson 9	Modular control work

Laboratory classes

LB 1	Introductory lesson. Safety equipment when working with electrical networks. Familiarity with the LabVIEW software product.
LB 2	VP, which determines the statistical thickness of the walls
LB 3	VP for determining statistical wall thickness using LabView
LB 4	Simulation of temperature change - Simulated temperature.
LB 5	VP calculation of pipeline operation with small losses
LB 6	Calculation of the necessary and sufficient number of parameter measurements during experimental research
LB 7	Analysis of hydroelectric generator modes
LB 8	VP theoretical and empirical frequency divisions
LB 9	VP to determine the variance

6. Independent work of the student

The hours allocated to the student's independent work are specified in clause 5. The method of mastering the academic discipline is preparation for the implementation and defense of practical and laboratory work, as well as preparation for the modular control work and assessment.

The student's independent work involves:

preparation for classroom classes - 48 hours;

preparation for the modular control work - 2 hours;

implementation of CGW - 10 hours;

preparation for the test - 6 hours

Policy and control

7. Policy of academic discipline (educational component)

Policy of academic discipline (educational component)

At the time of each lesson, both lecture, practical and laboratory, the student must have the Zoom application installed on the device from which he works (in the case of distance learning), as well asthe course is openVirtual instruments of engineering research" on the "Sikorsky" platform (the access code to the course is provided at the first lesson according to the schedule). Syllabus; lecture material; assignments for each practical and laboratory session; variants of modular control work; methodical recommendations for the implementation of KGW; variants of the modular control work are placed on the "Sikorsky" platform and in the "KPI Electronic Campus" system.

During the course «Virtual instruments of engineering research» students are obliged to adhere to the general moral principles and rules of ethical behavior specified in the Code of Honor of the National Technical University of Ukraine "Ihor Sikorskyi Kyiv Polytechnic Institute".

The deadlines for each task are specified in the course "Virtual instruments of engineering research" on the Sikorsky platform.

All students, without exception, are obliged to comply with the requirements of the Regulations on the Academic Plagiarism Prevention System at the National Technical University of Ukraine "Ihor Sikorskyi Kyiv Polytechnic Institute".

If the student of higher education was absent from the lecture, then he should practice this lecture at another time (with another group, at a consultation).

If the student of higher education was absent from practical and laboratory classes, he should complete these classes at another time (with another group, at a consultation).

The study of the educational discipline "Virtual devices of engineering research"
the needis from a higher education recipient:
- observance of educational and academic ethics;
- compliance with the schedule of the educational process;

- be balanced, attentive in classes;
- systematically study theoretical material;
- compliance with the schedule of protection of practical and laboratory works. The applicant's answer must demonstrate signs of independent performance of the assigned task, absence of signs of repetition and plagiarism.

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

Current control: tasks within the practical and laboratory classes (total 15×3 points = 45 points), MT (conducted directly in the practical class, in the presence of the teacher, 20 points), CGW (35 points).

Tasks within the framework of a practical or laboratory sessionare evaluated in 3 points according to the following criteria:

– "excellent" - a complete answer (at least 90% of the required information), appropriate justifications and a personal opinion are provided - 3 points;

– "good" - a sufficiently complete answer (at least 75% of the required information), which is completed in accordance with the requirements for the "skills" level or contains minor inaccuracies - 2 points;

– "satisfactory" - an incomplete answer (at least 60% of the required information), completed in accordance with the requirements for the "stereotype" level and containing some errors - 2 points;

– "unsatisfactory" - unsatisfactory answer - 0 points.

CGWis estimated at 35 points according to the following criteria:

– "excellent" - a complete answer (at least 90% of the required information), relevant justifications and a personal opinion are provided - 35 - 27 points;

– "good" - a sufficiently complete answer (at least 75% of the required information), which is completed in accordance with the requirements for the "skills" level or contains minor inaccuracies - 26 - 23 points;

– "satisfactory" - an incomplete answer (at least 60% of the required information), completed in accordance with the requirements for the "stereotype" level and containing some errors - 20 - 17 points;

– "unsatisfactory" - unsatisfactory answer - 0 points.

Requirements for writing CGW are provided in the form of methodological recommendations and are postedon the "Sikorsky" platform and in the "KPI Electronic Campus" system.

MT is carried out at the end of the semester, it is valued at 20 points according to the following criteria:

– "excellent" - a complete answer (at least 90% of the required information), a developed task project with correct answers - 20 - 18 points;

– "good" - sufficiently complete answer (at least 75% of the required information), the developed task project contains minor inaccuracies - 17 - 15 points;

– "satisfactory" - an incomplete answer (at least 60% of the required information), the developed task project contains some errors - 14 - 12 points;

– "unsatisfactory" - unsatisfactory answer - 0 points.

Calendar control: is held twice a semester as a monitoring of the current state of fulfillment of the syllabus requirements. The condition for a positive first and second calendar control is to obtain at least 50% of the maximum possible rating at the time of the corresponding calendar control.

Semester control: test. Test. Conditions for admission to the semester control: completed and credited practical and/or laboratory, MT and CGW.

Calculation of the rating scale (RS):

RC(max) = 15*3 + 1*35+1*20 = 100 points

RC(min) = 6*3 + 1*7+1*5 = 30 points

Students who have met all the admission requirements and have a rating of 60 or more points receive a rating corresponding to the rating without additional tests. The sum of the rating points received by the student during the semester is transferred to the final grade according to the table.

If the sum of points is less than 60, but the practical and/or laboratory, MT, CGW have been completed and credited, the student performs the control work.

The control work is estimated at 63 points. The control task of this paper consists of three theoretical questions from the list provided in the appendix to the syllabus.

Each question and task is evaluated in 21 points according to the following criteria:

- "excellent" - a complete answer (at least 90% of the required information), relevant justifications and a personal opinion are provided - 21 - 19 points;

- "good" - a sufficiently complete answer (at least 75% of the required information), which is completed in accordance with the requirements for the "skills" level or contains minor inaccuracies - 18 - 16 points;

- "satisfactory" - an incomplete answer (at least 60% of the required information), completed in accordance with the requirements for the "stereotype" level and containing some errors - 15 - 13 points;

- "unsatisfactory" - unsatisfactory answer - 0 points.

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

Scores	Rating
100-95	Perfectly
94-85	Very good
84-75	Fine
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 is given in the appendix to the syllabus

Control questions for self-examination of discipline
"Virtual instruments of engineering research"

Control questions for self-checking the material of Lecture 1
1.1. How to understand the abbreviated name of the shell**LabView?**
1.2. How is LabView different from other programming systems?
1.3. Purpose of the shell**LabView**
1.4. What does the LabView shell include?
1.5. What is the basis**LabView shell?**
1.6. What is the HiQ environment that is part of the LabView shell intended for?
1.7. What is the LabSuite environment focused on = LabView + Hi,
1.8. What is the LookOut software product that is part of the LabView shell based on?
1.9. What makes LookOut a software product?
1.10. What allows you to create a Bridge software product?
1.11. What is the sequential instrument control, data analysis, data presentation, and data storage in the LabView shell?
1.12. What does the concept of Wavelets mean?
Control questions for self-checking the material of Lecture 2
2.1. How many graphics palettes does the LabView shell have?
2.2. Assignment of LabView graphical palettes
2.3. What does the Tools palette contain and what is it for?
2.4. How to call the Tools palette - Tools on the screen?
2.5. What does the cursor look like after selecting the Show Tools Palette icon?
2.6. What does the purpose look like?**Management tool – Operate Value?**
2.7.What is the look and purpose of the Position-Size-Select tool?
2.8.What does the Text edit tool look like and what is its purpose?
2.9.What is the appearance and purpose of the tool**Connecting cable - Connect Wire?**
2.10.What is the look and purpose of the Scrolling tool - Scroll Window?

2.11. What is the appearance and purpose of the tool**Setting colors - Set Colors?**
2.12. What is the appearance and purpose of the tool**Probe data?**
2.13. Purpose of the Control Palette - Controls
2.14. What does the palette consist of Numerical values -**Numeric?**
2.15. What does the Boolean functions palette consist of -**Boolean?**
2.16. What does the palette consist of?**Term values**– String?
2.17. What does the palette consist of?**Array & Cluster Array & Cluster?**
2.18. What does the palette consist of?**List and Ringed list - List & Ring?**
2.19. What does the palette consist of?**Oscilloscopes -**Graph?
2.20. What does the palette consist of?**Path and Refnum - Path & Refnum?**
2.21. What does the palette consist of?**Registration -**Decorations?
2.22. What does it look like withwhat is included under the palette**User Controls?**

Control questions for self-checking the material of Lecture 3

3.1. Purpose of the Functions Palette
3.2. How are the function images displayed in the Functions palette?
3.3. What does the Structure Subpalette consist of?– Structures?
3.4. What does the Numerical functions sub-palette consist of -**Numeric?**
3.5. What does the Subpalette of Boolean functions consist of -**Boolean?**
3.6. What does the Subpalette of String (String) functions consist of -**String**?
3.7. What does the Array sub-palette consist of -**Array?**
3.8. What does the Cluster sub-palette consist of -**Cluster?**
3.9. What does the Comparison sub-palette consist of -**Comparison?**
3.10. What does the Sub-palette Time and dialogue consist of -**Time & Dialogue?**
3.11. What does the File Output and File Input sub-palette consist of -**File I/O?**

Control questions for self-checking the material of Lecture 4

4.1. How many main palettes (panels) does the LabVIEW shell have?
4.2. What elements**Controls palettes**most often used to create VP?
4.3. What is Node and why is it similar in other programming languages?
4.4. How many node types does the shell have for creating virtual appliances.
4.5. Designation as nodes Functions?
4.6. Assignment of Subroutine Nodes ?
4.7. What are Terminals and their purpose?
4.8. How many types of terminals are there?
4.9. Specify the purpose of the thickness and color of the connection wires on the block diagrams of the VP?
4.10. What does the user observe when he raises the "Coil" - "Connect Wire" tool to the terminal, the "unwound end of the cable" appears on the function panel?.
4.11. How can the user get help when working with the shell?

Control questions for self-checking the material of Lecture 5

5.1. How does the user know that the flowchart is compiled with errors?
5.2. How to view errors in the block diagram?
5.3. How to find what error occurred when assembling the VP scheme?
5.4. How to enable Trace modeVP schemes during execution?
5.5. How to complete the work program of the VPnode by anode?
5.6. Purpose of the Step Over top menu bookmark?
5.7. How to view the data during the operation of the VP?
5.8. Where is the Probe icon?
5.9. Purpose of control points of the block diagram?
5.10. What do the control points look like on the VP block diagram?

Control questions for self-checking the material of Lecture 6

6.1. What are the general features of the behavior of a molecular system mediated by?
6.2. What indicators characterize the state of the molecule?

6.3. What distribution is possible to display the movement of molecules?
6.4. When did Ludwig Boltzmann live and who was he?
6.5. What characterizes the Boltzmann distribution function?
6.6. Represent the Boltzmann distribution function [1]:
6.7. What characterizes the value of kT in the Boltzmann distribution?
6.8. What determines the coefficient $\exp[-p2/(2mkT)]$ in the Boltzmann distribution?
6.9. What determines the coefficient $\exp[-U(r)/(kT)]$ in the Boltzmann distribution?
6.10. What is determined using the Boltzmann distribution function?
6.11. How do you simplify the Boltzmann distribution function?
6.1.2. How is the internal energy of the environment determined and what does it depend on
6.13. Make a mathematical model of setting the temperature of the environment after external exposure.

Working program of the academic discipline (Syllabus):
Compiled by: Professor of the Department of Automation of Electrotechnical and Mechatronic Complexes
Ph.D., prof. Stefan Volodymyrovych Zaichenko
Adopted:by the AEMK department (protocol No. 17 dated 31.06.2023)
Agreed: Methodical commission of the ES IEE (protocol No. 9 dated 06.22.23)