



Virtual engineering research instruments

Syllabus of the academic discipline (Syllabus)

Academic discipline requirements

Level of higher education	Second (Master's)
Discipline	G – Engineering, Manufacturing and Construction
Specialty	G3 – Electrical Engineering
Educational program	Engineering of intelligent electrical and mechatronic complexes
Discipline status	Required
Form of study	Full-time
Year of training, semester	1st year, 1st fall semester
Scope of the discipline	4 credits, 120 hours
Semester control/control measures	Test
Class schedule	http://schedule.kpi.ua/
Language of instruction	English
Information about the course leader/teachers	Lecturer: Zaichenko S.V.
Course placement	https://classroom.google.com/

Program of the academic discipline "Virtual devices for engineering research"

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

The discipline "Virtual Devices of Engineering Research" examines the basic principles of computer modeling and research of the processes of functioning of electrical power, electrical engineering and electromechanical equipment. The main characteristics, engineering methods of calculating parameters and constructing virtual devices for designing installations are analyzed. The operating modes of virtual devices are created and investigated in the absence of real measuring devices for research.

The purpose of studying the discipline is to form in the student theoretical and practical knowledge in building virtual models of electromechanical systems using graphical programming tools.

The subject of study of the discipline is the LabVIEW program.

Program learning outcomes:

Competencies:(FK02) ability to apply knowledge in practical situations; (FK04) ability to demonstrate knowledge and understanding of mathematical principles and methods necessary for use in

power engineering, electrical engineering and electromechanics; (FK09) ability to use software for computer modeling, automated design, automated production and automated development or construction of elements of power engineering, electrical engineering and electromechanical systems; (FK12) ability to develop means, methods and methods of science and technology aimed at automating existing and creating new automated and automatic technologies and industries.

Skills:(PRN01) reproduce processes in electrical power, electrical engineering and electromechanical systems during their computer modeling; (PRN03) analyze processes in electrical power, electrical engineering and electromechanical equipment and related complexes and systems; (PRN05) possess methods of mathematical and physical modeling of objects and processes in electrical power, electrical engineering and electromechanical systems; (PRN07) plan and carry out scientific research and innovative projects in the field of electrical power, electrical engineering and electromechanics; (PRN15) perform physical and mathematical modeling, static and dynamic analysis of structures, mechanisms, materials and processes at the design stage, investigate the reliability of systems, using modern computer tools.

2. Prerequisites and postrequisites of the discipline (place in the structural and logical scheme of study according to the corresponding educational program)

The academic discipline "Virtual Devices of Engineering Research" is taught on the basis of knowledge and skills obtained by students during the study of credit modules of such disciplines as: "Computer Engineering and Programming", "Higher Mathematics", "General Physics", "Hydraulics and Hydropneumatic Drive". Related disciplines are: "Electric Drive", "Automation of Technological Processes".

3. Content of the academic discipline

4. Fundamentals of Virtual Instruments & System Interfaces
5. Development Tools & Mathematical Modeling
6. Scalar Data Types, Logic, & Conditionals
7. Complex Data Structures: Arrays & Clusters
8. Control Structures & Program Flow
9. Sequence Control, Modular Design, & Debugging
10. Real-Time & Waveform Graphical Visualization
11. Specialized & Multi-Dimensional Visualization
12. File I/O Operations & Signal Filtering
13. Signal Generation & Synthesis Techniques
14. DAQ Architecture & Physical Signal Classification
15. Signal Conditioning, Grounding, & Measurement Topology
16. Sampling Theory & Analog Input Acquisition
17. Advanced DAQ Configuration & Cascaded Systems
18. System Integration, Review, & Preparation for Assessment

4. Educational materials and resources

Basic literature:

1. **Sumathi, S., & Surekha, P.** (2007). *LabVIEW based Advanced Instrumentation Systems*. Springer, 725 p. ISBN: 978-3540485001.
2. **Bress, T.** (2013). *Effective LabVIEW Programming*. NTS Press, 720 p. ISBN: 978-1934891087.
3. **Travis, J., & Kring, J.** (2006). *LabVIEW for Everyone: Graphical Programming Made Easy and Fun* (3rd ed.). Prentice Hall, 1008 p. ISBN: 978-0131856721.

Supporting literature:

1. Terentyev, O. M., Vorfolomeyev, A. V., & Kleshchev, A. Y. (2016). Virtual devices for engineering research (Parts 1–4) [Methodological instructions for practical and laboratory works]. Igor Sikorsky Kyiv Polytechnic Institute.
2. Golovnya, V. M. (2023). Creating virtual devices in the LabVIEW environment [Teaching aid]. Igor Sikorsky Kyiv Polytechnic Institute.
3. Smutko, S. V., Maidan, P. S., & Lisevich, S. P. (2018). LabVIEW hardware and software complex: Laboratory practical. Khmelnytskyi National University.

Literature, the bibliography of which is given with a link, can be found on the Internet. Literature, the bibliography of which does not contain a link, can be found in the library of Igor Sikorsky Kyiv Polytechnic Institute. Required reading are certain sections of the basic literature [1-4]. The sections of the basic literature, which are required for reading, as well as the connection of these resources with specific topics of the discipline are given below, in the methodology for mastering the academic discipline. All other literary sources are optional, it is recommended to familiarize yourself with them

Educational content

5. Methodology for mastering the academic discipline (educational component)

Lecture classes

№	Chapter	Lecture Title	Main Topics Covered
1	Chapter 1. Introduction to Virtual Instrumentation	Fundamentals of Virtual Instruments & System Interfaces	Overview of VI architecture; navigation through toolbars, context menus, and main menus; principles of building UI for virtual devices.
2	Chapter 1. Introduction to Virtual Instrumentation	Development Tools & Mathematical Modeling	Structure and functions of control palettes and component libraries; implementing algorithms via formula nodes and embedded code.
3	Chapter 2. Data Types & Processing Techniques	Scalar Data Types, Logic, & Conditionals	Classification of data types (Numeric, Boolean, String); logical elements and conditional functions in graphical programming.
4	Chapter 2. Data Types & Processing Techniques	Complex Data Structures: Arrays & Clusters	Array creation, indexing, and manipulation; cluster operations; string processing and text manipulation functions.
5	Chapter 3. Control Structures	Control Structures & Program Flow	Classification of execution control structures; For loops (with auto-indexing) and While loops; Case structures and decision logic.

6	Chapters 4 & 5. Sub-modules & Debugging	Sequence Control, Modular Design, & Debugging	Sequence structures for execution ordering; modular sub-device design and connector interface configuration; probes, breakpoints, and step-by-step debugging.
7	Chapter 6. Graphical Information Display	Real-Time & Waveform Graphical Visualization	Overview of visualization tools; dynamic charts for continuous time-series data; multi-channel time-domain waveform graphs.
8	Chapter 6. Graphical Information Display	Specialized & Multi-Dimensional Visualization	XY graphs for non-uniform data; intensity graphs for heatmaps and matrix data; 3D spatial surface rendering and spatial graphs.
9	Chapters 7 & 8. Data I/O & Digital Signal Processing	File I/O Operations & Signal Filtering	File I/O architecture; reading/writing binary, text, and tabular files; digital signal processing fundamentals and digital filter design.
10	Chapter 8. Working with Signals	Signal Generation & Synthesis Techniques	Signal generation tools; mathematical signal synthesis using iterative loops; waveform generation using built-in signal processing blocks.
11	Chapter 9. Signal Measurement & DAQ Systems	DAQ Architecture & Physical Signal Classification	Functional structure of Analog DAQ hardware; classification of digital, analog level, time-domain, and frequency-domain signals.
12	Chapter 9. Signal Measurement & DAQ Systems	Signal Conditioning, Grounding, & Measurement Topology	Signal converters and conditioning; grounding principles in signal measurement; Differential, Common Grounded (RSE), and Common Ungrounded (NRSE) topologies.
13	Chapter 9. Signal Measurement & DAQ Systems	Sampling Theory & Analog Input Acquisition	Signal sampling and aliasing prevention (Nyquist-Shannon theorem); virtual measurement modules for single-point and continuous data scanning.
14	Chapter 9. Signal Measurement & DAQ Systems	Advanced DAQ Configuration & Cascaded Systems	Hardware channel initialization and parameter setup; hardware and software triggering mechanisms; multichannel acquisition via cascaded sub-systems.
15	Chapter 10. System Integration & Review	System Integration, Review, & Preparation for Assessment	Integration of DAQ, processing, visualization, and file storage modules into unified research systems; course review, debt settlement, and credit requirements.

Practical classes

No. of the company	Tasks assigned to practical classes	Number of hours
1	• Interface Design, Mathematical Modeling, and Control Structures in Virtual Instruments	2
2	• Complex Data Structures: Operations with Arrays, Clusters, and Strings	2
3	• Modular Architecture: SubVIs Creation, Sequence Execution, and Debugging Techniques	2
4	• Data Visualization: Real-Time Charts, Multi-Channel Graphs, and Spatial Displays	2
5	• File I/O Systems and Digital Signal Processing: Filtering and Data Logging	2
6	• Signal Generation, Synthesis Techniques, and Waveform Analysis	2
7	• Hardware Data Acquisition: Conditioning, Grounding Topologies, and Multi-Channel Scanning	2

6 Independent student work

Independent student work involves: 76 hours

Preparation for lectures: 16 hours

Preparation for practical classes: 31 hours

Completion of calculation work: 18 hours

Preparation for modular test work: 5 hours

Preparation for the test: 6 hours

Policy and control

7 Academic discipline policy (educational component)

Current control: MCW (modular control work) is carried out before the second calendar control at the lecture class in the presence of the lecturer (28 points), 9 practical classes (8 points per practical lesson = $9 \times 8 = 72$). MCW is performed in the form of an answer to a theoretical question from the lecture material and one practical work. At the end of the lesson, the work on the MCW ends and is not subject to rewriting. MCW is evaluated at 28 points according to the following criteria:

– "excellent" – a complete answer to the theoretical question (at least 90% of the required information), appropriate justifications and personal views are provided, and the problem is solved correctly – 28-23 points;

– "good" – a sufficiently complete answer to the theoretical question (at least 75% of the required information), which is made in accordance with the requirements for the level of "skills" or contains minor inaccuracies, the course of solving the problem is correct, but contains minor inaccuracies, mostly in the calculation – 22-17 points;

- "satisfactory" – an incomplete answer to a theoretical question (at least 60% of the required information), performed in accordance with the requirements for the "stereotyped" level and contains some errors, significant errors in solving problems are traced – 16-11 points;

- "unsatisfactory" – unsatisfactory answer and incorrectly solved problem – 0 points.

Tasks within the framework of the practical lesson are evaluated at 8 points according to the following criteria:

- "excellent" – fully completed work (at least 90% of the necessary information), appropriate justifications and personal opinion provided – 8 points;

- "good" – the work contains certain inaccuracies (at least 75% of the necessary information), the provided justifications are not complete enough – 7-6 points;

- "satisfactory" – the work contains significant inaccuracies (at least 60% of the required information), the work is performed in accordance with the requirements for the "stereotyped" level and contains significant errors – 5-5 points;

- "unsatisfactory" – the problem was solved incorrectly – 0 points.

Calendar control: is carried out twice a semester as a monitoring of the current state of fulfillment of the requirements of the syllabus. 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. A prerequisite for admission to the credit assessment is the writing of a modular test work and a starting rating of at least 30 points. $RC(max) = 28 + 72 = 100$ points $RC(min) = 30$ points.

Test assessment. Students who have fulfilled all the conditions for admission to the test and have a rating score of 60 or more points receive a grade corresponding to the rating scored without additional tests. The sum of rating points received by the student during the semester is converted to the final grade according to the table.

If the sum of points is less than 60, but the practical ones are completed and passed, the MCW, the student performs the test work. The test work is estimated at 100 points. The control task of this work consists of two theoretical questions from the list provided in the appendix to the syllabus and the problem. Each question is evaluated at 50 points according to the following criteria:

- "excellent" – complete answer (at least 95% of the required information), provided appropriate justifications and personal view – 47-50 points;

- "good" – a sufficiently complete answer (at least 75% of the required information) that has been completed according to the requirements for the level of "skills" or contains minor inaccuracies – 37-46 points;

- "satisfactory" – an incomplete answer (at least 60% of the required information) made in accordance with requirements for the "stereotyped" level and contains some errors – 30-36 points; –

- "unsatisfactory" – unsatisfactory answer – >30 points. Incentive points are set for:

Completing an individual semester assignment	depending on the complexity, but not more than 10 points
Report at relevant student conferences on the subject of the discipline and participation in competitions of works	up to 5 points
Preparation of an abstract work on the topic of the lesson missed by the student, or on the topic proposed by the lecturer (up to 10 sheets)	depending on the student's disclosure of the chosen topic, the validity of the conclusions, but not more than 3 points

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

<i>Rating Points, RD</i>	<i>University Scale Score</i>
$95 \leq RD \leq 100$	Perfectly
$85 \leq RD \leq 94$	Very good
$75 \leq RD \leq 84$	Well
$65 \leq RD \leq 74$	Satisfactory
$60 \leq RD \leq 64$	Enough
$RD < 60$	Disappointing
Failure to meet the conditions for admission to semester control	Not allowed

9. Changes

Compared to the syllabus for the 2024-2025 academic year, the following changes have been made:

Section 3 – supplemented content of the academic discipline.

Section 4 – expanded list of references.

Chapter 5:

- the list of lecture material has been supplemented in accordance with changes in the course content and the reduction in the number of lecture hours to 16;

- The list of computer workshops has been changed to take into account the lack of division of work into practical and laboratory.

Section 6 – changed allocation of time for independent work of students.

Section 7 – the academic discipline policy has been changed in terms of the transition to distance learning.

Section 8 – the rating system has been changed to take into account the increase in the number of points for the module test.

The working program of the academic discipline (Syllabus):

Compiled by: Candidate of Physical and Mathematical Sciences, Senior Lecturer Mykola Pavlovich Osadchuk

Approved by: the Department of AEMK (minutes No. 15 dated 04.06.2025)

Agreed: Methodological Commission of the NN IEE (minutes No. 30 dated 06/25/2025)