ACADEMIC DISCIPLINE SYLLABUS

RELAY PROTECTION AND AUTOMATION

Educational Level	First (bachelor)
Educational-Professional program	"Electrical energetics, electrical engineering and electromechanics"
Duration of teaching	13, 14 quarters
Classes:	
lectures:	2 hours
laboratory classes:	2 hours
practical classes:	1 hour
Language of teaching	English

Course page in the system of distance education of DUT:
https://do.nmu.org.ua/course/view.php?id=3051

Department of Electric Power Engineering

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1. Annotation to the course

The subject of the course is special devices of relay protection and anti-emergency automation in power supply systems. Modern systems of production, transmission and distribution of electrical energy require control and protection, which is reflected in the maintenance of normal operating modes of the main electrical equipment of electrical stations and substations. Relay protection devices have the main function of eliminating emergency and abnormal modes of operation of the main electrical equipment. Interfering with the main functions of relay protection, it must have four main properties (selectivity, speed, sensitivity, and reliability). Modern systems of relay protection and automation are built based on microprocessor devices and work based on digital standards such as IEC61850, and also have freely programmable work logic. The aspects listed above require a high level of qualification and a deep understanding of aspects of the operation of the main equipment of power stations, substations, and power networks.

During the construction of the course, the author considered modern trends in the development of microprocessor relay protection systems and preserved the basics of its theoretical principles.

The purpose of the discipline – formation of competences regarding the construction, principle of operation and analysis of processes in relay protection and automation systems.

Course objectives:

- to acquaint higher education seekers with the classification, purpose, general structure of relay protection devices and automation based on electromechanical, electrostatic and microprocessor base;
- to study the circuit solutions of protection devices depending on the objects of protection;
- to study the construction and principle of operation of drives of switching devices;
- consider schemes and principles of discrete connections of microprocessor relay protection terminals;
- get acquainted with the main characteristics of secondary measuring circuits of relay protection;
- get acquainted with the principles of construction of operational current circuits;
- to study methods of calculation of settings of operation of protection;
- learn to build relay protection selectivity maps;
- learn to take and analyze vector diagrams from relay protection devices;
- to get an idea of the possibilities of modern data exchange systems between relay protection devices.

The learning outcomes are to know and understand the theoretical foundations of metrology and electrical measurements, the principles of operation of automatic control devices, relay protection and automation, to have the skills to perform appropriate measurements and use these devices to solve professional tasks**.**

2. Structure of the Course

LECTURES	LABORATORY CLASSES	PRACTICAL CLASSES
1. Introduction "Basic principles of relay devices" 1.1. Purpose of relay protection devices and main properties 1.2. Relay principle of operation and basic elements of electromechanical relays 1.3. Relay types (measuring, logic and combined) **2. Analysis of emergency modes and types of protection** 2.1. Varieties of abnormal and emergency modes of equipment operation 2.2. Vector diagrams of normal, abnormal and emergency modes of operation of the main equipment 2.3. Types and scope of protection depending on the object **3. Measuring protection circuits** 3.1. Measuring transducers (current and voltage transformers) 3.2. Properties and modes of operation of measuring transducers 3.3. Circuit solutions of measuring transducers **4. Logic circuits of relay protection and automa-**	1. Investigation of the return coefficient of the electromagnetic relay current (RT-40) and voltage (PH-54) 2. Research of current relay operation with dependent characteristic (RT-80) 3. Study of the operation of the microprocessor protection terminal (RZL-01) (configuration, setting and testing of relay protection settings, connection of secondary circuits of the terminal) 4. Removal of vector diagrams and accident	1. Calculation of emergency operating mode currents 2. Calculation of OP settings 3. Calculation of DP settings 4. Construction of the selectivity map 5. Calculation of DPT

tion 4.1. Implementation of basic logic functions based on relay-contact circuits 4.2. LD and FBD language for PLC programming 4.3. The use of logical constructions for the implementation of simple network automation systems **5. Relay protection terminals** 5.1. The principle of operation of the terminal 5.2. Configuring the relay protection and automation terminal 5.3. Removal of the log of accidents and oscillograms 5.4. Removal and analysis of vector diagrams **6. Calculation of relay protection settings** 6.1.Calculation of three-stage maximum current protection 6.2 Calculation of minimum voltage protection 6.3 Calculation of remote protection 6.4 Calculation of transformer differential protection 6.5 Construction of selectivity maps	log of the terminal (RS-83AB2)	

3. Evaluation system and requirements

3.1. **The academic achievements of higher education students** based on the results of the course will be assessed on the scale below

Rating scale	Institutional scale
90 – 100	Excellent
74 – 89	Good
60 – 73	Satisfactory
0 – 59	Fail

3.2 Applicants of higher education can receive **a final grade** in the academic discipline based on the current assessment of knowledge, provided that the number of points scored is at least 60 points.

Maximum rating:

Theoretical part	The practical part	The laboratory part	Bonus	**Total**
60	20	20	5	**100**

The theoretical part is evaluated based on the results of passing the control test work, which contains 3 questions, which are open tests, each weighing 10 points. Assessment is carried out twice a semester during control measures, in accordance with the schedule of the educational process.

3.3 Evaluation criteria of theoretical work

Three open test questions are evaluated in **10 points each (30 points in total)**. The test survey is conducted using remote platform technology Moodle, Microsoft Office 365.

Wherein:

- **0 points** – there was no answer to the question or the answer was not relevant to the question;
- **2 points** – the answer is incomplete and contains only general data of the content of the question, or several serious mistakes were made in the answer;
- **4 points** – the answer is incomplete and contains a serious error or most of the answer is not related to the topic of the question;
- **6 points** – the answer basically reflects the essence of the question, but several inaccuracies were made or part of it does not correspond to the question, or the answer is sche-

matic without the necessary explanations;

- **8 points** – the answer fully corresponds to the question, but some explanations are missing or a slight inaccuracy is allowed, or there is no consistency in the answer;
- **10 points** – the answer fully corresponds to the question, contains the necessary explanations and drawings, is written concisely, consistently and competently, and also contains a situational analysis.

3.4. Criteria for evaluating laboratory work

The laboratory part consists of four laboratory works, each weighing 5 points (total 20 points). Laboratory works are performed and submitted consecutively during the respective semesters and must be submitted before the theoretical part is completed.

Correctly performed laboratory work is valued at 10 points (for the final semester), wherein:

- **5 points** – full compliance with the essence of the work;
- **4 points** – compliance with the essence of the work with minor deviations and inaccuracies;
- **3 points** – partial compliance with the essence of the work without its full disclosure;
- **2 points** – there are significant errors in the execution of the work;
- **0 points** – the work is not listed or does not relate to the topic of the work.

3.5. Evaluation criteria of practical work

The practical part consists of five problems, each worth 4 points (20 points in total). Practical tasks are performed independently during the semester. At the end of the first quarter, 3 tasks must be completed, and by the end of the semester – two more. Defense of tasks is carried out during control events, twice per semester.

Problems from the practical part are listed in the system Moodle, Microsoft Office 365. Problems solved on paper are scanned (photographed) and sent to the teacher's e-mail within the time allotted for passing the relevant module of the practical part. An answer sent late is considered as not submitted.

A correctly solved **task** is valued at 5 points, wherein:

- **5 points** – correspondence to the solution of the problem, with units of measurement;
- **4 points** – correspondence to the solution of the problem, without measurement units or errors in calculations;
- **3 points** – minor errors in formulas, without units of measurement;
- **2 points** – there are significant errors in the decision;
- **0 points –** the solution is not given.

3.6. Evaluation criteria of the final work

If the student of higher education received less than 60 points according to the current performance or seeks to improve the grade, **a final assessment (exam)** is conducted during the session.

The exam is conducted in the form of a complex control paper, which includes questions from the theoretical and practical part of the course. The ticket consists of three theoretical open tests and two practical open tests (tasks) each weighing 20 points **(100 points in total)**.

Wherein:

- **20 points** – full correspondence to the essence of the question;
- **15 points** – compliance with the essence of the question with minor deviations and inaccuracies;
- **10 points** – partial correspondence to the essence of the question without its full disclosure;
- **5 points** – there are significant errors in the performance of the test;
- **0 points** – the answer is not given or does not relate to the topic of the question.

4. Course policy

4.1. Academic Integrity Policy

Academic integrity of higher education students is an important condition for mastering the results of training in the discipline and obtaining a satisfactory grade from the current and final tests. Academic integrity is based on condemnation of the practices of copying (writing with external sources other than those permitted for use), plagiarism (reproduction of published texts by other authors without attribution), fabrication (fabrication of data or facts used in the educational process). The policy on academic integrity is regulated by the Regulation "Regulations on the system of prevention and detection of plagiarism at the Dnipro University of Technology ". http://www.nmu.org.ua/ua/content/activity/us_documents/System_of_prevention_and_detection_of_plagiarism.pdf.

In case of violation of academic integrity by a higher education applicant (copying, plagiarism, fabrication), the work is evaluated unsatisfactorily and must be repeated. The teacher reserves the right to change the topic of the task.

4.2. Communication policy

Applicants for higher education must have activated university mail.

All written questions to teachers regarding the course should be sent to the university e-mail.

4.3. Retaking policy

Works that are submitted in violation of deadlines without good reason are evaluated at a lower grade. Relocation takes place with the permission of the dean's office if there are good reasons (for example, sick leave).

4.4 Evaluation Appeal Policy

If the applicant does not agree with the assessment of his knowledge, he may protest the assessment given by the teacher in the prescribed manner.

4.5. Attending classes

For higher education students, full-time attendance is mandatory. For applicants for higher education who receive educational services under the Dual form of education, an individual schedule is provided. Good reasons for not attending classes are illness, participation in university events, academic mobility, which must be documented. The applicant for higher education must inform the teacher either in person or through the headmaster about the absence from classes and the reasons for absence.

For objective reasons (for example, academic mobility) training can take place online in consultation with the course leader.

5. Recommended sources of information

1. Кідиба В.П. Релейний захист електроенергетичних систем: Підручник. – Львів: Видавництво Національного університету "Львівська політехніка", 2013. – 533 с. / Kidiba V.P. Relay protection of power systems: Textbook. – Lviv: Publishing House of the National University "Lviv Polytechnic", 2013. – 533 p.
2. Букович Н.В. Автоматика електроенергетичних систем: Навч. посіб. — К.: ІЗМН, 1998. — 280. / Bukovich N.V. Automation of electric power systems: Training. manual — K.: IZMN, 1998. — 280.
3. Яндульський О. С., Дмитренко О. О. Релейний захист. Цифрові пристрої релейного захисту, автоматики та управління електроенергетичних систем: навч. посіб. Київ: НТУУ «КПІ», 2016. 102 с. / Yandulsky O. S., Dmytrenko O. O. Relay protection. Digital devices of relay protection, automation, and control of power systems: teaching. manual Kyiv: NTUU "KPI", 2016. 102 p.
4. Релейний захист і автоматика в системах електропостачання./ Говоров П.П. та ін. – К.: 1996 / Relay protection and automation in power supply systems./ Govorov P.P. etc. - K .: 1996;