Ministry of Education and Science of Ukraine

Dnipro University of Technology

Department of Electric Drive

"APPROVED"
Head of Department

KHudolii S. _____

«31» sugust 2021 year

CURRICULUM WORK PROGRAM

«Theory of electric drive»

Field of knowledge ……	14 Electrical Engineering
Specialty …… ...	141 Electric Power Engineering, Electrical Engineering and Electromechanics
Educational level …….	First (bachelor's)
Educational program …….	Electric Power Engineering, Electrical Engineering and Electromechanics
Status ……	selective
The total amount ..…….	7,5 ECTS credits (225 hours)
Form of final control …… ..	exam
Term of teaching …… ..	3rd, 4rd semesters
Language of instruction …….	English

Teacher: Beshta O.S.

Prolonged: on 20__/20__ t.y. _____(_____) «__»___ 20__year.
(signature, name, date)

on 20__/20__ t.y. _____(_____) «__»___ 20__year.
((signature, name, date)

Dnipro
DUT
2021

Working program of the discipline "Theory of electric drive" for bachelors majoring in 141 "Electric power, electrical engineering and electromechanics" / Dnipro University of Technology, Dept. electric drive. - D.: DUT», 2021. - 12 p.

Developer - prof. Beshta O.S.

The work program regulates:

- the purpose of the discipline;
- disciplinary learning outcomes formed on the basis of the transformation of the expected learning outcomes of the educational program;
- basic disciplines;
- the volume and distribution of forms of organization of the educational process and types of classes;
- discipline program (thematic plan by types of training sessions);
- algorithm for assessing the level of achievement of disciplinary learning outcomes (scales, tools, procedures and evaluation criteria);
- tools, equipment and software;
- recommended sources of information.

The work program is designed to implement a competency-based approach to planning the educational process, teaching the discipline, preparing students for control activities, control of educational activities, internal and external quality control of higher education, accreditation of educational programs within the specialty.

Approved by the decision of the Scientific-Methodical Commission of specialty 141 «Electric Power Engineering, Electrical Engineering and Electromechanics» at the request of the Department of Higher Mathematics (protocol № 21\22-01 dated 30.08.2021).

CONTENT

1 PURPOSE OF THE COURSE

The purpose of the discipline - the formation of competencies in the construction, principle of operation and analysis of processes in electromechanical systems with rigid and elastic connections, the study of the dynamics of electric drive with DC and AC motors.

Achieving the goal requires the transformation of program learning outcomes into disciplinary and adequate selection of the content of the discipline according to this criterion.

2 EXPECTED DISCIPLINARY LEARNING OUTCOMES

Theory of electric drive

Disciplinary learning outcomes (ДРН)	
DLO code	**content**
ДРН.01	Understand the properties of the mechanical part of the electric drive, taking into account the elastic elements
ДРН.02	Understand the equations of a generalized electric machine and be able to use them to analyze dynamic mechanical characteristics
ДРН.03	Be able to analyze electromechanical transients and the principles of their formation
ДРН.04	Understand the laws of frequency control of AC motors
ДРН.05	Understand energy and resource conservation in electric drives

3 BASIC DISCIPLINES

Subjects	Learning outcomes obtained
Б5 Fundamentals of electric engineering	ПР05 Know the basics of electromagnetic field theory, methods of calculating electric circuits and be able to use them to solve practical problems in professional activities.
Ф1 Electric machines	ПР03 Know the principles of operation of electric machines, devices and automated electric drives and be able to use them to solve practical problems in professional activities

4 SCOPE AND DISTRIBUTION BY FORMS OF ORGANIZATION OF THE EDUCATIONAL PROCESS AND TYPES OF EDUCATIONAL CLASSES

Type of training sessions	**Volume,** *hours*	**Distribution by forms of study,** *hours*					
		day		**evening**		**correspondence**	
		Lecture classes	independent work	Lecture classes	independent work	Lecture classes	independent work
lectures	124	119	51	-	-	-	-
practical	30	30	9	-	-	-	-
laboratory	56	76	21	-	-	-	-
TOGETHER	225	81	144	-	-	-	-

5 DISCIPLINE PROGRAM BY TYPES OF EDUCATIONAL CLASSES

DLO code	Types and topics of training sessions	Volume of components, *hours*
	LECTURES	**119**
ДРН1	**1 Mechanics of the electric drive taking into account elasticity**	7
	Equations of motion, transfer functions, and block diagrams of a two-mass system.	
	Dynamic properties of the mechanical part of the electric drive. Influence of gaps in transfers.	
	Mechanical characteristics of working bodies of industrial mechanisms. Steady motion and its stability.	
ДРН2	**2 Generalized electric machine**	30
	Generalized electric machine. Equation of electric equilibrium and moment of a generalized machine.	
	Transformation of coordinates and phases of a generalized machine. Equation of dynamic mechanical characteristics of a generalized machine in different coordinate systems.	
ДРН3	**3 Electromechanical transients**	26
	Formation of transients in systems "Controlled converter - engine".	
	Transient process taking into account electromechanical inertia.	
	Transients of electric drive with nonlinear mechanical characteristic.	
	Formation of transients in excitation windings.	
ДРН4	**4 Vector control of AC motors**	30
	Laws of frequency control of coordinates of an induction motor.	
	Adjustment of coordinates of the induction motor at frequency control.	
	Vector methods of controlling the coordinates of an asynchronous electric drive.	
	Functional diagrams of vector control with rotor coupling vector orientation.	
	Synchronous motor torque adjustment.	
	Adjusting the torque and speed of the synchronous electric drive during vector control.	
	Position adjustment. Accurate positioning.	
ДРН5	**5 Energy saving by means of the electric drive**	26
	Reduction of energy losses in transient modes by changing the control effect.	
	Minimize the loss of unloaded engines.	
	Energy and resource saving in electric drives of centrifugal mechanisms.	
	Ways of energy saving by means of the electric drive.	
	LABORATORY WORKS	76
ДРН2	Speed control in the GM system with feedback.	8
ДРН2	Speed control in the TC-M system with feedback.	8
ДРН2	Research of characteristics of TFC-ACM system.	8

ДРН2	Investigation of the characteristics of the TC-M system with subordinate coordinate control	8
ДРН1	Investigation of the characteristics of a two-mass elastic system	10
ДРН3	Experimental determination of dynamic drive parameters.	8
ДРН3	Investigation of heating and cooling of blood pressure.	8
ДРН3	Investigation of transients of DC motors	8
ДРН3	Investigation of transients of AC motors	10
	PRACTICAL TRAINING	30
ДРН3	Calculation of electromechanical transients.	7
ДРН2	Calculation of characteristics of control system of speed of the DC motor with one regulator in case of various feedbacks	7
ДРН2	Calculation of current control circuit (torque) parameters in the TC-M system, and estimation of static error.	8
ДРН5	Calculation of engine power	8
	Together:	**225**

COURSE PROJECT

The purpose of the course project is to expand, deepen and consolidate the knowledge gained in lectures and laboratory classes, as well as to acquire skills of independent work of electric drive design.

To do this, you will need to learn to determine the parameters of the main components of the electric drive - motor and frequency converter, analyze the load diagram of the drive, calculate equivalent loads, choose the motor, frequency drive and brake resistor.

6 EVALUATION OF LEARNING OUTCOMES

Certification of student achievement is carried out through transparent procedures based on objective criteria in accordance with the University Regulations "On the evaluation of learning outcomes of higher education."

The achieved level of competencies in relation to the expected ones, which was identified during the control activities, reflects the real result of the student's study in the discipline.

6.1 Scales

Assessment of academic achievements of students of NTU "DP" is carried out on a rating (100-point) and institutional scales. The latter is necessary (in the official absence of a national scale) for the conversion (translation) of assessments of higher education students from different institutions.

Scales for assessing the academic achievements of students of NTU "DP"

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

Credits of the discipline are credited if the student received a final grade of at least 60 points. The lower grade is considered to be academic debt, which is subject to liquidation in accordance with the Regulations on the organization of the educational process of NTU "DP".

6.2 Means and procedures

The content of diagnostic tools is aimed at controlling the level of knowledge, skills, communication, autonomy and responsibility of the student according to the requirements of the NQF to the 8th qualification level during the demonstration of learning outcomes regulated by the work program.

The student in the control activities must perform tasks focused solely on the demonstration of disciplinary learning outcomes (Section 2).

Diagnostic tools provided to students at control activities in the form of tasks for current and final control are formed by specifying the initial data and the way of demonstrating disciplinary learning outcomes.

Diagnostic tools (control tasks) for the current and final control of the discipline are approved by the department.

The types of diagnostic tools and assessment procedures for the current and final control of the discipline are given below.

Diagnostic and assessment procedures

CURRENT CONTROL			**SUMMARY CONTROL**	
training session	**diagnostic tools**	**procedures**	**diagnostic tools**	**procedures**
lectures	control tasks for each topic	performing the task during lectures	complex control work (CCR)	determination of the weighted average result of current controls; performing KKR during the exam at the request of the student
practical	control tasks for each topic	performing tasks during practical classes		
	or individual task	performing tasks during independent work		
Laboratory	control tasks for each topic or individual task	performing tasks during independent work		

During the current control, lectures are evaluated by determining the quality of the specific tasks. Practical classes are assessed by the quality of the control or individual task.

If the content of a particular type of lesson is subject to several descriptors, the integral value of the assessment can be determined taking into account the weights set by the teacher.

If the level of results of current controls in all types of classes is at least 60 points, the final control is carried out without the participation of the student by determining the weighted average of current assessments.

Regardless of the results of the current control, each student during the exam has the right to perform the CCR, which contains tasks that cover key disciplinary learning outcomes.

The number of specified tasks of the CCR should correspond to the allotted time for execution. The number of CRC options should provide individualization of the task.

The value of the assessment for the implementation of the CCR is determined by the average assessment of the components (specified tasks) and is final.

The integral value of the assessment of the implementation of the CCR can be determined taking into account the weights set by the department for each descriptor of the NQF.

6.3 Criteria

Actual student learning outcomes are identified and measured relative to what is expected during the follow-up activities using criteria that describe the student's actions to demonstrate the achievement of learning outcomes.

To assess the performance of control tasks during the current control of lectures and practical classes as a criterion is used the coefficient of mastery, which automatically adapts the assessment indicator to the rating scale:

$$O_i = 100\ a/m,$$

where ***a*** is the number of correct answers or significant operations performed according to the decision standard; ***m*** is the total number of questions or significant operations of the standard.

Individual tasks and complex tests are assessed expertly using criteria that characterize the ratio of requirements to the level of competencies and indicators of assessment on a rating scale.

The content of the criteria is based on the competency characteristics defined by the NQF for the master's level of higher education (below).

General criteria for achieving learning outcomes for the 6th qualification level according to the NQF

NRC descriptors	**Requirements for knowledge, skills, communication, autonomy and responsibility**	**Indicator estimates**
	Knoleges	
Conceptual scientific and practical knowledge, critical thinking of theories, principles, methods and concepts in the field of professional activity and / or training	The answer is excellent - correct, reasonable, meaningful.	95-100
	Characterizes the presence of:	90-94
	- specialized conceptual knowledge at the level of the latest achievements;	85-89
	- critical understanding of problems in teaching and / or professional activities and at the boundaries of subject areas	80-84
	The answer contains minor errors or omissions	75-79
	The answer is correct, but there are some inaccuracies	70-74
	The answer is correct, but has some inaccuracies and is insufficiently substantiated	65-69
	The answer is correct, but has some inaccuracies, insufficiently substantiated and meaningful	60-64
	The answer is fragmentary	<60
	Skills	
In-depth cognitive and practical skills, mastery and innovation at the level required to solve complex specialized tasks and practical problems in the field of professional activity or training	The answer characterizes the ability to:	95-100
	- identify problems;	90-94
	- formulate hypotheses;	85-89
	- solve problems;	80-84
	- update knowledge;	75-79
	- integrate knowledge;	70-74
	- to carry out innovative activity;	65-69
	- to carry out scientific activity	60-64
	The answer characterizes the ability to apply knowledge in practice with minor errors	<60
	Communication	
• bringing to specialists and non-specialists information, ideas, problems, solutions, personal experience and arguments • data collection, interpretation and application •communication on professional issues, including in a foreign	Clarity of the answer (report). Language: - correct; - clean; - clear; - accurate; - logical; - expressive; - concise. Communication strategy: - consistent and consistent development of thought; - the presence of logical own judgments; - relevant argumentation and its compliance with the defended provisions; - correct structure of the answer (report); - correct answers to questions;	95-100

NRC descriptors	Requirements for knowledge, skills, communication, autonomy and responsibility	Indicator estimates
language, orally and in writing	- appropriate technique for answering questions; - ability to draw conclusions and formulate proposals; - - use of foreign languages in professional activities	
	Sufficient clarity of the answer (report) and appropriate communication strategy with minor flaws	90-94
	Good clarity of response (reports) and appropriate communication strategy (three requirements not met in total)	85-89
	Good clarity of response (reports) and appropriate communication strategy (four requirements not implemented in total)	80-84
	Good clarity of response (report) and appropriate communication strategy (five requirements not met in total)	75-79
	Satisfactory clarity of response (report) and appropriate communication strategy (seven requirements not implemented in total)	70-74
	Satisfactory clarity of response (report) and communication strategy with errors (nine requirements not implemented in total)	65-69
	Satisfactory comprehensibility of the answer (report) and communication strategy with errors (10 requirements not implemented in total)	60-64
	The level of communication is unsatisfactory	<60
Autonomy and responsibility		
• managing complex technical or professional activities or projects • ability to take responsibility for making and making decisions in unpredictable work and / or learning contexts formation of judgments that take into account social, scientific and ethical aspects • organization and management of professional development of	Excellent competence: - use of principles and methods of organizing team activities; - effective distribution of powers in the team structure; - maintaining a balanced relationship with team members (responsibility for the relationship); - stress resistance; - self-regulation; - work activity in extreme situations; - high level of personal attitude to the case; - mastery of all types of educational activities; - appropriate level of fundamental knowledge; - - the appropriate level of formation of general skills and abilities	95-100
	Confident mastery of autonomy and responsibility with minor flaws	90-94
	Good mastery of autonomy and responsibility competencies (two requirements not met)	85-89
	Good mastery of autonomy and responsibility competencies (three requirements not met)	80-84
	Good mastery of autonomy and responsibility competencies (four requirements not met)	75-79

NRC descriptors	Requirements for knowledge, skills, communication, autonomy and responsibility	Indicator estimates
individuals and groups • ability to continue learning with a significant degree of autonomy	Satisfactory ownership of autonomy and responsibility (five requirements not met)	70-74
	Satisfactory mastery of autonomy and responsibility competencies (six requirements not met)	65-69
	Satisfactory mastery of autonomy and responsibility competencies (fragmentary level)	60-64
	The level of autonomy and responsibility is unsatisfactory	<60

7 TOOLS, EQUIPMENT AND SOFTWARE

Technical training.

Remote platform MOODLE, MS Teams.

8 RECOMMENDED SOURCES OF INFORMATION

8.1 Basic

1. Колб Ант.А., Колб А.А. Теорія електроприводу [Текст]: навч. посібник. – 2-ге вид., перероб. і доп. – Д.: Національний гірничий університет, 2011. – 565 с.
2. Теорія електропривода: Підручник / М.Г. Попович, М.Г. Борисюк, В.А. Гаврилюк та ін.; за ред. М.Г. Поповича. –К.: Вища шк., 1993. -494 с.
3. Піцан Р., Барадачевський В., Бойчук Б. Збірник задач до курсу «Електропривод». – Львів, Видавництво «Львівська політехніка», 1999. – 426 с.

8.2 Additional

1. Elektrische Maschinen und Antriebe/ E.Nolle, A.Beshta; National Mining University. – D: NMU, 2013. – 232 p.
2. Попович М.Г., Ковальчук О.В. Теорія автоматичного керування: Підручник. – К.: Либідь, 1997. – 544 с.
3. Теорія електроприводу: Збірник задач / Булгар В.В. - Одеса: Поліграф, 2006. – 408 с.

9 INFORMATIONAL SOURCES

1. Literature on the website of the Department of Electric Drive: **https://elprivod.nmu.org.ua/ua/books/automaticED.php**

Навчальне видання

РОБОЧА ПРОГРАМА НАВЧАЛЬНОЇ ДИСЦИПЛІНИ
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