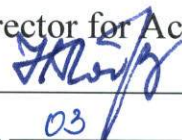


Ministry of Science and Higher Education of the Russian Federation  
 Federal State Budgetary Educational Institution of Higher Education  
**Perm National Research Polytechnic University**

**APPROVED BY**

Pro-rector for Academic Affairs

 N.V. Lobov

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**ACADEMIC COURSE WORKING PROGRAM**

**Academic course:** Electrotechnics and electronics  
 (Name)

**Form of education:** Full-time  
 (Full-time /full-time – correspondence/correspondence)

**Level of higher education:** Bachelor's program  
 (Bachelor's program/specialist program/  
 Master's program)

**Workload in hours (in credits):** 144(4)  
 (Hours (CU))

**Training program (degree):** 21.03.01 Oil and Gas Engineering  
 (Code and denomination of degree)

**Direction:** Oil and Gas Engineering  
 (Title of curriculum)

## 1. GENERAL PROVISIONS

### 1.1. GOALS AND OBJECTIVES OF THE COURSE

The goal of the discipline is to form knowledge, skills and abilities in the field of electrical engineering and electronics, for calculating electrical circuits, measuring their parameters, typical circuit solutions in the field of electronics and skills for calculating the elements of these systems, design and operation of various complexes of electrical equipment.

### 1.2. STUDIED OBJECTS OF THE COURSE

Study of the main provisions of the theory and practice of calculating single-phase and three-phase electrical circuits, devices and principles of operation of electrical machines and electrical equipment; the main basic elements of electronics, typical circuit solutions, and the main directions of development of these systems; formation of the ability to choose standard circuit solutions for power supply systems for various sets of technological equipment, assess risks and determine measures to ensure safety; development of skills in research, analysis and calculation of electrical circuits and processes in them, elements of circuits of electronics and electrical equipment.

### 1.3. STARTING CONDITIONS

Unstipulated

## 2. PLANNED RESULTS OF THE COURSE TRAINING

Competence	Indicator's Index	Planned Results of the Course Training (to know, to know how, to master)	Indicator of Attaining Competence which the planned results of training are correlated with	Means of Assessment
1	2	3	4	5
GPC-1	IA-1 <sub>gpc-1</sub>	<b>To know</b> the basic laws of electrical engineering and methods for calculating linear electrical circuits and the possibility of their use in practical applications.	<b>Knows</b> principle features of modelling mathematical, physical and chemical processes assigned for definite technological processes.	Test
	IA-2 <sub>gpc-1</sub>	<b>Be able</b> to apply theoretical knowledge to solve practical problems in electrical engineering.	<b>Is able to</b> use general laws of the disciplines of mechanical-engineering module; to use general laws of natural-scientific disciplines, the rules of technical drafting and plotting.	Report on practical work



1	2	3	4	5
	IA-3 <sub>gpc-1</sub>	<b>To masters:</b> – basic procedures of technological analysis in electrical engineering; – participates knowledgeably in the work aimed at production processes improvement using electrical engineering experimental data.	<b>Masters</b> basic procedures of technological and economic analysis, has the skill of drafting as a member of creative team; participates knowledgeably in the work aimed at production processes improvement using experimental data and results of modelling; masters business interaction with maintenance department and can estimate their recommendations taking into account experimental work of the enterprise technological department.	Report on laboratory work; test
GPC-4.	IA-1 <sub>gpc-4</sub>	<b>To know</b> the purpose and principle of operation of electrical measuring devices used in professional activities; methods of making measurements and observations, processing and presenting experimental data in electrical engineering.	<b>Knows</b> the procedure of conducting typical experiments on the standard equipment in laboratory and at industrial enterprise	Report on laboratory work
	IA-2 <sub>gpc-4</sub>	<b>Be able to</b> use electrical measuring devices; process and present experimental data	<b>Is able to</b> process the results of research using standard equipment, instrumentation and materials.	Report on laboratory work
	IA-3 <sub>gpc-4</sub>	<b>To master the skills</b> of independent scientific and technical experiment, processing and presentation of its results with the use of software package.	<b>Masters</b> the experimentation technique with the use of software package.	Report on laboratory work
GPC-6	IA-1 <sub>gpc-6</sub>	<b>To know</b> the main principles of information-communication technologies in electrical engineering.	<b>Knows</b> the principles of information-communication technologies and basic information security requirements.	Test
	IA-2 <sub>gpc-6</sub>	<b>Be able to</b> choose the most suitable from the standard methods for calculating the characteristics of electrical devices with the use of modern technologies.	<b>Is able to</b> solve standard tasks of professional activity on the basis of informational and bibliographic culture with the use of modern technologies and information security requirements.	Report on practical work

1	2	3	4	5
	IA-3 <sub>gpc-6</sub>	To master the skills in using standard methods of selection and calculation of electrical devices on the basis of modern information technologies.	Masters the skill of solving standard problems of professional activity on the basis of modern information technologies and information security requirements.	Report on laboratory work

### 3. FULL TIME AND FORMS OF ACADEMIC WORK

Form of academic work	Hours in all	Distribution in hours according to semesters
		Number of semester 5
1. Holding classes (including results monitoring) in the form: 1.1. Contact classwork, including:		
– lectures (L)	18	18
– laboratory work (LW)	16	16
– practice, seminars and/or other seminar-typework (PW)	16	16
– control of self-work (CSW)	4	4
– test	–	–
1.2. Students' self-work (SSW)	90	90
2. Intermediate attestation		
Exam	–	–
Grading test	–	–
Test (Credit)	–	–
Course Project (CP)	–	–
Course Work (CW)	–	–
<b>Workload in hours</b>	<b>144</b>	<b>144</b>

### 4. COURSE OUTLINE

Name of the units with the course outline	Full time of classroom activity in hours according to the forms			Full time of extracurricular work in hours according to the forms
	L	LW	PW	SSW
1	2	3	4	5
<b>semester</b>				
Module 1. Electrical circuits	6	6	6	18
Section 1. DC circuits. Basic concepts and definitions, circuit elements, classification of electrical circuits, modes of operation of electrical circuits, basic laws of electrical engineering. DC circuits, connection methods, circuit conversion. Calculation of circuit methods: equivalent resistance, use of Kirchhoff circuits. Power in DC circuits, power balance.				



1	2	3	4	5
<p>Section 2. Single-phase sinusoidal current circuits. Obtaining a sinusoidal current, basic information. The main parameters of the sinusoidal function. RMS value of alternating current. Image of a sinusoidal function in vectors. Circuits with ideal elements: resistor R, inductance L, capacitance C, vector diagrams. Sequential contour with elements R, L, C, method of vector diagrams. Parallel contour with elements R, L, C, graphic-analytical method of calculation. The phenomenon of resonance in an electrical circuit. Power in sinusoidal current circuits, power balance. Power factor.</p> <p>Section 3. Three-phase circuits. The concept of three-phase circuits, obtaining a three-phase symmetric EMF system in industry, connecting EMF and loads with a star and a triangle. Phase and line voltage. Symmetrical and unbalanced loads. Calculation of three-phase circuits when connecting a load with a star. Calculation of three-phase circuits when connecting a load with a delta-com. Vector diagrams. Power in three-phase circuits.</p>				
Module 2. Electric machines	8	6	6	20
<p>Section 1. Transformers. Transformers, purpose and application area. The device and principle of operation of a single-phase transformer. Modes of operation. Equations of electrical equilibrium of the transformer. Magnetic flux in the transformer. Vector diagram of the transformer. The device and application area of three-phase transformers.</p> <p>Section 2. Electric machines. Asynchronous three-phase motors, purpose, device and principle of operation. The efficiency of the induction motor. Sliding and modes of operation. Mechanical characteristics. Speed control. Starting an asynchronous motor. DC electric machines, device and classification. Purpose of the brush-collector assembly. Machine operation in generator and engine mode. Speed control. DC motor start Synchronous machine device and principle of operation.</p>				
Module 3. Electronics	4	4	4	12
<p>Section 1. Introduction to modern electronics. Definition of modern electronics, classification and characteristics of its directions, the main problems. Elemental base. The principle of operation of the n-p junction. Properties of the n-p junction in electrodynamic equilibrium, as well as an external source connected to the forward and reverse voltage. Current-voltage characteristic.</p> <p>Section 2. Element base of modern electronics. Review of semiconductor devices. Classification, definitions, graphic symbols, application area. Brief</p>				

1	2	3	4	5
characteristics of semiconductor resistors. Semiconductor diodes. Single Phase AC Rectifier Structure				
Total with regard to semester	18	16	16	50
Total with regard to the course	18	16	16	90

### Topics of exemplary practical work

Sl.No	Topic of practical (seminar) work
1	Calculation of circuit methods: equivalent resistance, use of Kirchhoff circuits.
2	Sequential circuit with elements R, L, C, method of vector diagrams.
3	Parallel circuit with elements R, L, C, graphic-analytical method of calculation.
4	Calculation of three-phase circuits with a star connected load.
5	Calculation of three-phase circuits with a delta connected load.
6	A single-phase transformer the operating mode calculation.
7	An induction motor mechanical characteristics calculation.
8	Calculation of resistances in the forward and reverse connection of germanium and silicon semiconductor diodes.
9	Calculation of ripple factors for various circuits of conversion electronic devices.

### Topics of exemplary laboratory practice

Sl.No	Topic of laboratory work
1	Mixed connection of elements in a DC circuit.
2	AC electric circuit with serial connection of elements.
3	Study of a three-phase circuit when connecting consumers according to the "star" scheme.
4	Study of a single-phase two-winding transformer.
5	Research of a direct current separately excited generator.
6	Investigation of an asynchronous motor with a squirrel-cage rotor.
7	Study of germanium and silicon semiconductor diodes.
8	Evaluation of the ripple of single-ended and push-pull circuits on rectifying semiconductor diodes when rectifying a single-phase alternating current.

## 5. ORGANIZATIONAL AND PEDAGOGICAL CONDITIONS

### 5.1. EDUCATIONAL TECHNOLOGIES USED FOR COMPETENCES FORMATION

Holding lectures in the discipline is based on the active method of training in the process of which students are not passive but active participants of the lesson answering questions of the teacher. Teacher's questions are aimed at activating the process of learning material as well as at the development of logical thinking. The questions stimulating associative thinking and connecting new material with the previous one are identified by the teacher in advance.

Practical lessons are held by realization of the method based on active training: problem areas are determined, groups are formed. The following aims are pursued in the process of practical education: use of definite disciplines knowledge



and creative methods in solving problems and decision-making; students' skill-building of teamwork, interpersonal communication and development of leadership skills; consolidation of the basic theoretical knowledge.

Laboratory classes are based on an interactive learning method in which students communicate not only with the teacher but also with each other. At the same time, students' activity in the learning process dominates. The teacher's place in interactive classes is reduced to orienting students' activities to achievement of the goals of studies.

Interactive lectures, group discussions, role-playing games, training sessions, and analysis of situations and simulation models are used in academic studies

## 5.2. STUDENTS' MANUAL FOR THE COURSE STUDY

Learning the course students are recommended to fulfill the following positions:

1. Learning of the discipline should be done systematically.
2. After learning one of the course unit with the help of the text-book or lecture notes it is recommended to reproduce in memory the basic terms, definitions, notions of the unit.
3. Special attention should be paid to the reports on practical studies, laboratory works and individual complex tasks for self-work.
4. The topic of questions studied individually is given by the teacher at the lectures. Also the teacher refers to the literary resources (first of all, to the newly published in periodicals) in order the students understand the problems touched on the lectures in detail.

## 6. LIST OF TEACHING MATERIALS AND INFORMATION SUPPLY FOR STUDENTS' SELF WORK IN THE DISCIPLINE

### 6.1. PAPER-BASED COURSEWARE

Sl.No	Bibliographic entry (author, title, mode of publication, place, publishing house, year of publication, number of pages )	Number of copies in the library
<b>1</b>	<b>2</b>	<b>3</b>
<b>1. Basic literature</b>		
1	Tyunina E. Electrical Engineering. M.: Flinta, 2009. 154 p.	4
<b>2. Additional literature</b>		
<b>2.1. Educational and scientific literature</b>		
1	Alberty R. A. Thermodynamics of Biochemical Reactions. New Jersey : Wiley-Interscience, 2003. 397 p.	1
2	Liley P. E. 2000 solved problems in mechanical engineering thermodynamics. New York : McGraw-Hill Publ. Co, 1989. 406 p.	1
3	Electro. SamSTU: ACB, 2018. 157 p.	1
4	Teleguz A. Electrical drive. Novosibirsk: NSTU, 2019. 98 p.	1

<b>1</b>	<b>2</b>	<b>3</b>
5	Ryan C. W. Basic Electricity. New York : John Wiley & Sons, Ins, 1976. 280 p.	1
<b>2.2. Standardized and Technical literature</b>		
<b>3. Students' manual in mastering discipline</b>		
<b>4. Teaching and learning materials for students' self work</b>		

## 6.2. ELECTRONIC COURSEWARE

<b>Kind of literature</b>	<b>Name of training tool</b>	<b>Reference to information resource</b>	<b>Accessibility of EBN (Internet/local net; authorized free assess )</b>
Basic literature	Basic Electrotechnology	<a href="https://link.springer.com/book/10.1007/978-1-349-01705-8">https://link.springer.com/book/10.1007/978-1-349-01705-8</a>	local net; authorized assess
Basic literature	Applied Electrotechnology for Engineers	<a href="https://link.springer.com/book/10.1007/978-1-349-15679-5">https://link.springer.com/book/10.1007/978-1-349-15679-5</a>	local net; authorized assess
Additional literature	An Introduction to Aspects of Thermodynamics and Kinetics Relevant to Materials Science / New York : Elsevier, 2007.	URL: <a href="https://elib.pstu.ru/Record/RUPNRPUelib4250">https://elib.pstu.ru/Record/RUPNRPUelib4250</a>	local net; authorized assess
Basic literature	Microelectronics : From Fundamentals to Applied Design	<a href="https://www.springer.com/gp/book/9783319225449">https://www.springer.com/gp/book/9783319225449</a>	local net; authorized assess

## 6.3. LICENSE AND FREE DISTRIBUTED SOFTWARE USED IN THE COURSE EDUCATIONAL PROCESS

<b>Type of Software</b>	<b>Software branding</b>
OS	Windows 10 (Azure Dev Tools for Teaching)
Office Applications	Adobe Acrobat Reader DC
Image processing software	Corel Corel DRAW Suite X4
General purpose application software	Mathematical Professional Version(license L3263-7820*)
General purpose application software	Microsoft Office Visio Professional 2016 (Azure Dev Tools for Teaching)
General purpose application software	WinRAR (license №879261.1493674)
Management systems for projects, research, development, design, modeling and implementation	Autodesk AutoCAD 2019 Education Multi-seat Stand-alone



#### 6.4. MODERN PROFESSIONAL DATABASES AND INQUIRY SYSTEMS USED IN THE COURSE EDUCATIONAL PROCESS

<b>Branding</b>	<b>Reference to information resource</b>
Scopus database	<a href="https://www.scopus.com/">https://www.scopus.com/</a>
Web of Science Database	<a href="https://www.webofscience.com/">https://www.webofscience.com/</a>
Company database EBSCO	<a href="https://www.ebsco.com/">https://www.ebsco.com/</a>
Scientific Library of the Perm National Research Polytechnic University	<a href="https://lib.pstu/">https://lib.pstu/</a>

#### 7. LOGISTICS OF THE COURSE EDUCATIONAL PROCESS

<b>Type of classes</b>	<b>Name of the necessary basic equipment</b>	<b>Number of units</b>
Laboratory session	Stand "Electric circuits"	5
Laboratory session	Stand "Electric machines and electric drive"	5
Lecture	Multimedia complex consisting of: multimedia projector, acoustic system. Desks, teacher's table, whiteboard, chairs.	1
Practical lesson	Multimedia complex consisting of: multimedia projector, acoustic system. Desks, teacher's table, whiteboard, chairs.	1

#### 8. FUND OF THE COURSE EVALUATING TOOLS

Described in a separate document

Ministry of Science and Higher Education of the Russian Federation  
Federal State Budgetary Educational Institution of Higher Education  
**Perm National Research Polytechnic University**

## **FUND OF ESTIMATING TOOLS**

**For students' midterm assessment in the discipline**  
**“Electrotechnics and electronics”**  
*Supplement to the Academic Course Working Program*

<b>Training program</b>	21.03.01 Oil and Gas Engineering
<b>Direction (specialization) of educational program</b>	Oil and Gas Engineering
<b>Graduate qualification</b>	Bachelor's degree
<b>Graduate academic chair</b>	Oil and Gas Technology
<b>Form of study</b>	Full-time studies
<b>Year (-s): 3</b>	<b>Semester (-s): 5</b>

**Workload:**

in credits: 4 CU

in hours: 144 h

**The form of midterm assessment:**

Test 5 semester



**Fund of estimating tools** for midterm assessment of students' learning the subject "Electrotechnics and electronics" is the part (supplement) to the academic course working program. Fund of estimating tools for midterm assessment of students' learning the discipline has been developed in accordance with the general part of the fund of estimating tools for midterm assessment of the basic educational program which determines the system of the midterm assessment results and criteria of putting marks. Fund of estimating tools for midterm assessment of students' learning the subject determines the forms and procedures of monitoring results and midterm assessment of the subject leaning by the students.

### 1. LIST OF CONTROLLED RESULTS OF STUDYING DISCIPLINE, OBJECTS OF ASSESSMENT AND FORMS OF CONTROL

According to the Academic Course Working Program mastering course content is planned during one semester (the fifth semester of curriculum) and is divided into three educational modules. Classroom activities, lectures and laboratory work as well as students' self-work are provided for every module. In the frames of mastering course content such competences as *to know*, *to be able*, *to master* pointed out in the ACWP are formed. These competences act as the controlled results of learning the discipline " Electrotechnics and electronics " (Table 1.1).

Monitoring of the acquired knowledge, abilities and skills is made in the frames of continuous assessment, progress check and formative assessment in the process of studying theoretical material, reports on laboratory works and during examination. Types of control is given in Table 1.1

Table 1.1 – List of controlled results of learning the discipline

Controlled results of learning the discipline (KAS)	Type of control					
	Continuous assessment		Progress check		Formative assessment	
	D	AC	LWR/PWR	T/CW		Test
1	2	3	4	5	6	7
<b>Acquired knowledge</b>						
K.1 Knows principle features of modelling mathematical, physical and chemical processes assigned for definite technological processes.	D					Test
K.2 Knows the procedure of conducting typical experiments on the standard equipment in laboratory and at industrial enterprise	D		LWR			
K.3. Knows the principles of information-communication technologies and basic information security requirements.	D					Test
<b>Acquired abilities</b>						
A.1 Is able to use general laws of the disciplines of mechanical-engineering module; to use general laws of natural-scientific disciplines, the rules of technical drafting and plotting.			PWR			

1	2	3	4	5	6	7
A.2 Is able to process the results of research using standard equipment, instrumentation and materials.			LWR			
A.3. Is able to solve standard tasks of professional activity on the basis of informational and bibliographic culture with the use of modern technologies and information security requirements.			LWR			
<b>Mastered skills</b>						
S.1 Masters basic procedures of technological and economic analysis, has the skill of drafting as a member of creative team; participates knowledgeably in the work aimed at production processes improvement using experimental data and results of modelling; masters business interaction with maintenance department and can estimate their recommendations taking into account experimental work of the enterprise technological department.			LWR			Test
S.2 Masters the experimentation technique with the use of software packages.			LWR			
S.3 Has the skill of solving standard problems of professional activity on the basis of modern information technologies and information security requirements.			LWR			

*D – topic discussion; AC – colloquium (discussion of theoretical material, academic conference); CT – case-task (individual task); LWR – report on laboratory work; PWR – report on practical work; T/CW – progress check (control work); TQ – theoretical question; PT – practical task; CT – complex task of grading test.*

Final assessment of the learned discipline results is the midterm assessment which is made in the form of test taking into consideration the results of the running and progress check.

## **2. TYPES OF CONTROL, STANDARD CONTROL TASKS AND SCALES OF LEARNING RESULTS ASSESSMENT**

Continuous assessment of the academic performance is aimed at maximum effectiveness of the educational process, at monitoring students' specified competencies formation process, at increase of learning motivation and provides the assessment of mastering the discipline. In accordance with the regulations concerning the continuous assessment of the academic performance and midterm assessment of students taught by the educational programs of Higher education – programs of the Bachelor's Course, Specialists' and Master's Course the next types of students' academic performance continuous assessment and its periodicity is stipulated in PNRPU:

– acceptance test, check of the student's original preparedness and his correspondence with the demands for the given discipline learning;



- continuous assessment of mastering the material (the level of mastering the component “to know” defined by the competence) at every group studies and monitoring of lectures attendance;

- interim and progress check of students’ mastering the components “to know” and “to be able” of the defined competences by computer-based or written testing, control discussions, control works (individual home tasks), reports on laboratory works, reviews, essays, etc.

Discipline progress check is conducted on the next week after learning the discipline module, while the interim control is made at every monitoring during the discipline module study;

- interim assessment, summarizing of the current students’ performance at least once a semester in all disciplines for every training program (specialty), course, group;

- retained knowledge control.

## 2.1. CONTINUOUS ASSESSMENT OF EDUCATION

Continuous assessment of learning is made in the form of discussion or selective recitation on every topic. According to the four-point system the results of assessment are put into the teachers’ note-book and are considered in the form of integral marks in the process of the midterm assessment.

## 2.2. PROGRESS CHECK

For the complex assessment of the acquired knowledge, abilities and skills (Table 1.1) progress check is carried out in the form of laboratory work presentation and midterm control works (after learning every discipline module).

### *2.2.1. Presentation of laboratory work*

It is planned 8 laboratory work is planned all in all. Standard topics of laboratory work are given in ACWP.

Presentation of laboratory work is made by the student individually or by the group of students. Standard scale and criteria of assessment are given in the general part of FET of the educational program.

### *2.2.2. Midterm control work*

According to ACWP 2 midterm control works (CW) are planned to be realized after learning the educational modules of the discipline by the students.

The first CW is realized with respect to the module 1 “Electrical circuits”, the module 2 “Electric machines” and the module 3 “Electronics”.

**Standard tasks of the first CW:**

1. Basic concepts, circuit elements, basic laws.
2. Transformers, purpose and application area.

**Standard tasks of the second CW:**

1. Sources of power supply and electrical installations.
2. Semiconductor diodes, conventional designation, structure, purpose and classification of diodes.

Standard scale and criteria of the results of the midterm control work assessment are given in the general part of FET of the educational program.

### 2.3. FULFILLMENT OF THE COMPLEX INDIVIDUAL SELF-WORK TASK

Individual complex tasks for the students are used for assessment of their skills and abilities acquired in the process of learning the discipline in which the course project or course paper is not stipulated.

Standard scale and criteria of assessment of the individual complex task presentation are given in the general part of FET of the educational program.

### 2.4. MIDTERM ASSESSMENT (FINAL CONTROL)

Admission for midterm assessment is made according to the results of continuous assessment and progress check. Preconditions for admittance are successful presentation of all laboratory works and positive integral estimation with respect to the results of continuous assessment and progress check.

#### *2.4.1. Midterm assessment procedure without additional evaluation testing*

Midterm assessment is made in the form of a test. Credit on the discipline is based on the results of the previously fulfilled by the student individual tasks on the given discipline.

Criteria of putting the final mark for the components of competences in the process of midterm assessment made in the form of test are given in the general part of FET of the educational program.

#### *2.4.2. Midterm assessment procedure followed by evaluation testing*

In definite cases (for example, in case of re-attestation of the discipline) midterm assessment in the form of the test on this discipline can be made as the card-based evaluation test. Every card includes theoretical questions(TQ) aimed at control of the acquired knowledge, practical tasks (PT) aimed at mastered abilities, and complex tasks (CT) aimed at control of the acquired skills of all declared competences.



The card is formed so that the included questions and practical tasks could estimate the level of maturity of **all** declared competences.

#### **2.4.2.1. Standard questions and tasks the discipline testing**

##### **Standard questions for the acquired knowledge control:**

1. DC circuits, conversion of circuits.
2. Circuits with ideal elements: resistor R, inductance L, capacitance C, vector diagrams.
3. Three-phase circuits, connections of EMF and loads with a star and a delta.
4. The structure and principle of operation of a single-phase transformer.
5. Asynchronous three-phase motors, purpose, classification, structure and principle of operation.
6. Electric machines of direct current, classification, structure and principle of operation.
7. Synchronous three-phase machines and their structure.
8. Power supply in enterprises and laboratories.
9. Classification of electrical lines and networks.
10. Measurement errors and instrument accuracy classes.
11. Bipolar transistors: conventional designation, structure, purpose and their classification.
12. Block diagram of the secondary power supply, rectifiers, smoothing filters, voltage stabilizers.

##### **Standard questions and practical tasks for the mastered abilities control:**

1. Calculation of a direct current electric circuit.
2. Calculation of a single-phase sinusoidal alternating current circuit.
3. Calculation of a three-phase sinusoidal alternating current circuit.
4. Calculation of a single-phase two-winding transformer.
5. Calculation of a three-phase asynchronous motor.
6. Calculation of the generator (motor) direct current.
7. Calculation of the transistor amplifier.

##### **Standard complex tasks for the acquired skills control:**

1. Study of a direct current circuit with a mixed connection of elements.
2. Study of an alternating current circuit with a series connection of elements, voltage resonance.
3. Study of a three-phase circuit when connecting receivers according to the "star" scheme.
4. Investigation of the characteristics of a single-phase two-winding transformer.
5. Investigation of the performance characteristics of an induction motor with a squirrel-cage rotor.

6. Investigation of the characteristics of a direct current generator of independent and parallel excitation.
7. Investigation of the operating modes of the power transmission line.
8. Research of properties and characteristics of semiconductor devices (diodes, bipolar transistors).
9. Research of properties and characteristics of electronic devices (amplifiers of electrical signals, operational amplifiers).

#### **2.4.2.2. Scales of test assessment of educational achievements**

Evaluation of discipline achievements in the form of maturity level of the components *to know, to be able, to master the* declared competences is made according to the four-point assessment scale.

Standard scale and criteria of estimating educational achievements in the process of testing for the components *to know, to be able, to master* are given in the general part of FET of educational program.

### **3. ASSESSMENT CRITERIA FOR COMPONENTS AND COMPETENCES LEVEL OF MATURITY**

#### **3.1. ASSESSMENT OF COMPETENCES COMPONENTS LEVEL OF MATURITY**

While estimating the level of competences maturity by selective control in the process of testing it is considered that *the mark obtained for the components of the examined competence is combined with the corresponding component of all competences formed in the frames of the given academic course.*

General assessment of maturity level of all competences is made by aggregation of marks obtained by the student for each component of the formed competences taking into account the results of continuous assessment and progress check in the form of integral mark according to the four-point scale. All control results are put into the assessment sheet by the teacher according to the results of midterm attestation.

The form of the assessment sheet and requirements for its completion are given in the general part of FET of the educational program.

While making the final assessment of the midterm attestation in the form of test standard criteria given in the general part of FET of the educational program are used.