

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution for Higher Education
«North-Caucasus Federal University»

APPROVED BY

Dean of FPE of NCFU

Candidate of Technical Sciences,

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ASSESSMENT TOOLS FOR THE DISCIPLINE (MODULE)
« Digital Simulation of Power Systems »

Field of study	<u>13.04.02 Electric Power Engineering and Electrical Engineering</u>
Specialization (Profile)	<u>Training Program of Electrical Engineering</u>
Year of commencement of studies	<u>2026</u>
Mode of study	<u>full-time</u>
Implemented in semester(s)	<u>2</u>

Foreword

1. Purpose: This assessment tools (AT) document is intended to assess the level of competency formation during ongoing progress control and intermediate assessment of students in the discipline " Digital Simulation of Power Systems ".

2. The AT is an appendix to the syllabus of the discipline " Digital Simulation of Power Systems".

3. Developer: A.A.Stepanova, Candidate of Technical Sciences, Associate Professor at the Department of Automated Electric Power Systems and Power Supply

4. The AT has undergone expert review.

Members of the expert group:

Chairperson: Yu. G. Kononov, Doctor of Technical Sciences, Professor, Head of the Department of Automated Electric Power Systems and Power Supply.

Committee members:

D.A. Kostyukov, Candidate of Technical Sciences, Associate Professor, Department of Automated Electric Power Systems and Power Supply.

A.V. Petrov, Candidate of Technical Sciences, Associate Professor, Department of Automated Electric Power Systems and Power Supply.

Representative of the employer organization:

S.A. Filippov, Candidate of Technical Sciences, Head of the Leninsky District Department of the Stavropol Interdistrict Branch of the PJSC «Stavropolenergosbyt».

Expert opinion: The AT is recommended for assessing the level of competency formation during ongoing progress control and intermediate assessment of students in the discipline " Digital Simulation of Power Systems".

5. The validity period of the AT is determined by the period of implementation of the educational program.

1. Description of indicators and criteria for assessment at various stages of their formation, description of grading scales

Competency(ies), indicator(s)	Levels of competency formation			
	Minimum level not achieved (Unsatisfactory) – 2 points	Minimum level (Satisfactory) – 3 points	Medium level (Good) – 4 points	High level (Excellent) – 5 points
PC-1. Capable of participating in research and development activities in the field of electrical power engineering				
Learning outcomes for the discipline (module): Indicator: ID-3 PC-1. Compiles reports and presents the results of completed work.	Fails to structure and present the results of completed work; cannot compile a technical report; lacks understanding of documentation standards and presentation principles in electrical power engineering.	Compiles simple technical reports with significant instructor assistance; presents results using basic formatting; demonstrates limited ability to interpret simulation data and justify conclusions.	Confidently compiles structured technical reports and presents the results of completed work in accordance with professional standards; correctly interprets simulation data and provides justified conclusions with only minor inaccuracies in documentation.	Expertly compiles comprehensive research reports and delivers persuasive presentations of completed work to diverse audiences; proposes innovative approaches to data visualization and critically defends engineering solutions based on digital simulation results..
PC-3. Capable of managing the power system operating mode of an electrical power supply system using digital technologies				
Learning outcomes for the discipline (module): Indicator: ID-3 PC-3. Applies knowledge of digital technologies in the processes of generation, transmission, and distribution of electrical energy.	Fails to apply digital technologies to power system processes; lacks basic knowledge of digital tools in the energy sector; cannot solve the assigned task.	Applies basic digital technologies to simple tasks in power generation, transmission, or distribution; requires instructor guidance when dealing with complex scenarios.	Confidently applies standard digital tools to manage power processes; correctly selects and uses technologies for typical generation, transmission, and distribution tasks with only minor inaccuracies.	Expertly applies advanced digital technologies to optimize generation, transmission, and distribution; proposes innovative, well-justified solutions for complex power system operating modes..

ASSESSMENT TOOLS FOR CHECKING THE LEVEL OF COMPETENCY FORMATION

Task No.	Correct Answer	Question Content	Competency
1.	B	What conceptually defines a "slack bus" (or reference bus) when calculating a steady-state mode in a simulator? A) The bus that consumes all the reactive power in the network B) The bus that maintains specified voltage and angle, compensating for the active and reactive power imbalance C) The bus representing a purely active load D) The bus that automatically disconnects during a short circuit	PC-3, PC-1
2.	B	What type of input data is typically used in a simulator to represent the daily generation profile of a solar power plant? A) A constant value of DC voltage B) A tabular time profile (e.g., from CSV/Excel) showing power variation C) The physical weight of the solar panels D) The color temperature of sunlight	PC-3, PC-1
3.	B	What is the main goal of steady-state analysis (Load Flow) in digital simulation? A) To determine short-circuit currents during emergency situations B) To determine bus voltages, power flows, and losses under normal operating conditions C) To simulate mechanical rotor oscillations of a generator D) To design the physical layout of equipment at a substation	PC-3, PC-1
4.	C	If the simulation results show that the voltage at a load bus has dropped significantly below nominal (e.g., to 0.85 p.u.), what does this most often indicate? A) The system has an excess of reactive power B) The transmission line is operating in no-load mode C) The network has a deficit of reactive power or heavily loaded lines D) The generator is operating at maximum efficiency	PC-3, PC-1

5.	C	How will the active power losses in a transmission line conceptually change if the current flowing through it increases by a factor of 2? A) They will remain the same B) They will increase by a factor of 2 C) They will increase by a factor of 4 D) They will decrease by a factor of 2	PC-3, PC-1
6.	B	Why is "What-If" scenario analysis conducted in power system simulation software? A) To automatically write the text part of a technical report B) To evaluate system behavior under changing conditions (e.g., line disconnection or load growth) C) To compile an equipment specification for procurement D) To translate the software interface into another language	PC-3, PC-1
7.	B	What is the key conceptual difference between a "digital substation" (IEC 61850 standard) and a traditional one? A) Digital substations do not use power transformers B) Analog copper cables for control and signaling circuits are replaced by digital data communication networks (GOOSE messages) C) Digital substations can only generate energy from renewable sources D) Digital substations do not require high-voltage circuit breakers	PC-3, PC-1
8.	B	What role do Advanced Metering Infrastructure (AMI / smart meters) play in the digital simulation of distribution networks? A) They physically increase the voltage in the network B) They provide detailed time-stamped consumption and generation data for accurate load profiling C) They completely eliminate the need for power flow calculations D) They provide cooling for power transformers	PC-3, PC-1
9.	C	Which visual indicator is most commonly used in simulators to denote an overloaded transmission line on a single-line diagram? A) The line turns green B) The line disappears from the screen C) The line changes color (e.g., to red) or displays a warning icon/loading percentage D) The line thickens and starts blinking	PC-3, PC-1
		What is the most effective strategy for presenting digital simulation results to a non-technical audience (management, investors)? A) Demonstrate complex mathematical matrices and differential equations B) Show raw log files with the algorithm's output	PC-3, PC-1

10.	C	C) Use clear visual materials (charts, color schemes) and focus on practical conclusions (reliability, economics, losses) D) Read the entire 50-page technical report aloud from beginning to end	
11.		Define the term "steady-state operating mode" (Load Flow) in the context of digital power system simulation.	PC-3, PC-1
12.		What is a "slack bus" (reference bus) in a power system model?	PC-3, PC-1
13.		Define the concept of a "single-line diagram."	PC-3, PC-1
14.		What is a "digital substation" according to the IEC 61850 standard?	PC-3, PC-1
15.		What is a GOOSE message in the context of digital substations?	PC-3, PC-1
16.		Define the term "Advanced Metering Infrastructure" (AMI).	PC-3, PC-1
17.		What is "What-If Analysis" in power system simulation?	PC-3, PC-1
18.		What is a "load profile" in digital simulation?	PC-3, PC-1
19.		Define the concept of a "digital twin" of a power system.	PC-3, PC-1
20.		Steady-state analysis (Load Flow) determines bus voltages, power flows through lines, and power ____.	PC-3, PC-1
21.		A ____ diagram is a simplified graphical representation of a three-phase power system, in which all three phases are depicted by a single line.	PC-3, PC-1
22.		In a power system model, the ____ bus (slack bus) compensates for the active and reactive power imbalance, ensuring the convergence of the load flow calculation.	PC-3, PC-1
23.		Low voltage at a load bus often indicates a deficit of ____ power in the power system.	PC-3, PC-1
24.		The ____ standard defines the architecture of digital substations, where analog signals are replaced by digital data streams.	PC-3, PC-1
25.		Advanced Metering Infrastructure (AMI) enables ____ information exchange between the consumer and the utility.	PC-3, PC-1
26.		Active power losses in a transmission line are proportional to the ____ of the current flowing through it.	PC-3, PC-1
27.		"What-If" scenario analysis is used to evaluate power system behavior under ____ operating conditions	PC-3, PC-1

		(e.g., line disconnection or load growth).	
28.		A digital _____ is a virtual model of a physical power system that is updated in real time based on sensor data.	PC-3, PC-1
29.	1-B 2-C 3-A	Match the types of buses in load flow calculation with their characteristics: 1) Slack bus 2) PV bus (generator) 3) PQ bus (load) A) Active and reactive powers are specified (load or generation) B) Voltage magnitude and angle are specified, compensates for power imbalance C) Active power and voltage magnitude are specified	PC-3, PC-1
30.	1-A, 2-B, 3-C	Match the power system components with their typical representation in digital models: 1) Solar power plant 2) Power transformer 3) Smart meter (AMI) A) Source with a specified time-based generation profile B) Passive element with transformation ratio and impedance C) Device providing time-stamped consumption data	PC-3, PC-1
31.	1-A, 2-B, 3-C	Match the types of analysis with the tasks they solve: 1) Steady-state (load flow) calculation 2) "What-If" scenario analysis 3) Short-circuit calculation A) Determination of voltages and power flows under normal conditions B) Assessment of system reliability under configuration changes C) Determination of maximum currents for equipment selection	PC-3, PC-1

2. Description of the grading scale

Within the framework of the rating system, student performance in each discipline is assessed during ongoing progress control and intermediate assessment. The rating system for assessing student knowledge is based on the use of a set of control measures (checkpoints) for testing the material covered, optimally located throughout the entire time interval of studying the discipline. The principles of the rating system for assessing student knowledge are based on the provisions described in the "Regulations on the organization of the educational process based on the rating system for assessing student knowledge" at North Caucasus Federal University.

The rating assessment system is not provided for students studying in master's degree programs, or for students studying in bachelor's degree programs by correspondence or part-time (evening) forms of study.

3. Criteria for assessing competencies

The grade "Excellent" is awarded to a student who has deeply and firmly mastered the program material, presents it exhaustively, consistently, clearly, and logically coherently, is able to closely link theory with practice, handles tasks, questions, and other types of knowledge application with ease, and does not struggle to answer when assignments are modified.

The grade "Good" is awarded to a student who has a solid command of the material, presents it competently and substantively without making significant inaccuracies in answering questions, correctly applies theoretical principles to practical questions and tasks, and possesses the necessary skills and techniques for their execution.

The grade "Satisfactory" is awarded to a student who has knowledge of only the basic material but has not mastered its details, makes inaccuracies, insufficiently correct formulations, and violates logical sequence in presenting the program material.

The grade "Unsatisfactory" is awarded to a student who does not know a significant part of the program material and makes substantial errors.