

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,

Associate Professor A.E. Verisokin

ASSESSMENT TOOLS FOR THE DISCIPLINE (MODULE)
«Advanced Analysis 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>3</u>

Stavropol 2026

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 "Advanced Analysis of Power Systems".
- 2. The AT is an appendix to the syllabus of the discipline "Advanced Analysis of Power Systems".**
- 3. Developer:** Evgenii G. Zelenskii, Candidate of Technical Sciences, Associate Professor.
- 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 "Advanced Analysis 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-2 Capable of participating in the design of objects of professional activity				
Indicator: ID-1 PC-2. Performs calculation and analysis of the economic and technical characteristics of the object being designed;	The student has a fragmented understanding of the technical and economic characteristics of power engineering objects. They are unable to independently perform power flow calculations or analyze their results. When solving problems, the student makes gross errors in applying basic formulas, cannot justify the choice of method, and lacks proficiency in using specialized software. The student is unable to interpret the obtained data or draw conclusions about the technical and economic efficiency of the designed object.	The student knows the basic concepts and fundamental methods for calculating technical and economic indicators. They are able to perform calculations for simple electrical circuits and steady-state regimes under the guidance of an instructor or by following a template, using standard formulas. However, they struggle with the analysis of complex systems, cannot always independently choose the optimal solution method, and have incomplete proficiency with software functionality. The student can complete a task using a ready-made algorithm but is unable to adapt it to non-standard conditions.	The student possesses the methods for calculating and analyzing the technical and economic characteristics of power engineering objects. They can confidently perform power flow and stability analysis calculations for complex networks using specialized software. The student is able to analyze the obtained results, identify bottlenecks in system operation, and propose options for their elimination. They can justify the technical and economic feasibility of proposed design solutions by comparing several alternatives.	The student has a comprehensive command of a wide range of methods for analyzing and optimizing power systems. They are able to independently formulate a problem, select the most effective solution algorithm (including nonlinear programming methods), and implement it in software. The student can conduct a comprehensive analysis of complex technical solutions, assess their impact on the economy and reliability of the entire system, and critically evaluate scientific literature to find optimal approaches. They demonstrate a deep understanding of the subject and the ability to conduct research-level work within the scope of this competence.

ASSESSMENT TOOLS FOR CHECKING THE LEVEL OF COMPETENCY FORMATION

Task No.	Correct Answer	Question Content	Competency
1.	b)	What is the primary goal of State Estimation in a power system? a) Calculation of short-circuit currents b) Obtaining the most accurate estimate of the state vector (voltages and phases) based on inaccurate measurements c) Optimization of power generation dispatch d) Analysis of dynamic stability	PC-2
2.	b)	Which method for solving power flow equations is most widely used in modern software due to its fast convergence? a) Gauss-Seidel Method b) Newton-Raphson Method c) Reduced Gradient Method d) Z-bus Method	PC-2
3.	c)	What is the fundamental assumption of the Symmetrical Components method? a) The network is considered linear and balanced. b) The network is considered non-linear and unbalanced. c) All network elements have identical parameters for positive, negative, and zero sequences. d) Generators in the network are not accounted for.	PC-2
4.	c)	Which of the following criteria is used to assess the static stability of a load node? a) Criterion $dP/d\delta > 0$ b) Criterion $dV/dQ < 0$ c) Criterion $dP/dV > 0$ d) Criterion $d\delta/dt = 0$	PC-2
5.	b)	What is the principle of the "N-1" criterion in power system reliability analysis? a) The system must remain operational with the simultaneous outage of N-1 lines. b) The system must remain operational with the outage of any one element. c) The probability of failure for one element must be less than 1/N. d) Generation capacity must exceed the load by a factor of N-1.	PC-2
6.	c)	Which matrix is key when forming power flow equations in current mismatch form? a) Jacobian Matrix b) Incidence Matrix c) Y-bus (Admittance) Matrix d) Eigenvalue Matrix	PC-2
7.	b)	Which device or algorithm is designed to increase the power transfer capability of a transmission line by controlling the line's own parameters?	PC-2

		a) APFC (Automatic Power Flow Controller) b) FACTS (Flexible AC Transmission Systems) c) AVR (Automatic Voltage Regulator) d) LFC (Load Frequency Control)	
8.	b)	Which statistical test is most commonly applied to detect the presence of gross errors ("bad data detection") in SCADA data before running State Estimation? a) Student's t-test b) Chi-square test c) Fisher's F-test d) Durbin-Watson test	PC-2
9.	b)	The Park's equations are used for modeling: a) The steady-state operation of the network. b) Electromechanical transients in synchronous machines. c) Loss optimization in the network. d) Calculation of the Y-bus matrix.	PC-2
10.	b)	What is the primary objective of Economic Dispatch? a) To minimize power losses in the network. b) To minimize the total cost of generation while meeting demand. c) To ensure maximum stability margin. d) To equalize the droop coefficients of all generators.	PC-2
11.		Explain the physical meaning and mathematical formulation of the "Equal Area Criterion" for analyzing transient stability.	PC-2
12.		Describe the Weighted Least Squares (WLS) algorithm for State Estimation. What is the role of the Jacobian matrix in this process?	PC-2
13.		Compare the Newton-Raphson and Gauss-Seidel methods for solving power flow equations. State the advantages and disadvantages of each.	PC-2
14.		What are "bad data" in the context of SCADA systems? Describe the two main stages of their processing: detection and identification.	PC-2
15.		Write the power balance equation for node i in a network and explain the meaning of each term in this equation (generation, load, losses).	PC-2
16.	b)	What is the primary objective of Economic Dispatch? a) To minimize power losses in the network. b) To minimize the total cost of generation while satisfying the demand. c) To ensure the maximum stability margin. d) To equalize the droop coefficients of all generators.	PC-2
17.	c)	Which of the following statements about the Newton-Raphson method is correct? a) It does not require the calculation of derivatives. b) It always converges to a solution from any initial approximation. c) It has quadratic convergence near the solution.	PC-2

		d) It is slower than the Gauss-Seidel method for large systems.	
18.	b)	The Symmetrical Components method is applied for the analysis of: a) Only symmetrical modes. b) Unsymmetrical modes (single-line-to-ground, line-to-line faults). c) Only steady-state modes. d) Only dynamic transient processes.	PC-2
19.	b)	What is "droop" (speed droop) of a turbine governor? a) The speed of reaction to a frequency change. b) The dependence of a generator's power change on a system frequency change. c) The maximum allowable power of a generator. d) The regulator's delay time.	PC-2
20.	b)	What type of data do PMUs (Phasor Measurement Units) provide that distinguishes them from traditional SCADA measurements? a) Only the voltage amplitude. b) Time-synchronized vector quantities (amplitude and phase). c) Average power values over an interval. d) Equipment temperature.	PC-2
21.	b)	Optimal Power Flow (OPF) differs from Economic Dispatch in that it: a) Considers only fuel cost. b) Considers additional constraints (voltage limits, current limits, stability). c) Does not require an iterative solution. d) Is only applied to DC systems.	PC-2

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.