

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

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ASSESSMENT TOOLS FOR THE DISCIPLINE (MODULE)
«Modern Power Electronics»

Field of study	<u>13.04.02 Electric Power Engineering and Electrical Engineering</u>
Specialization (Profile)	<u>Intelligent Power Supply Systems</u>
Year of commencement of studies	<u>2026</u>
Mode of study	<u>full-time</u>
Implemented in semester(s)	<u>2</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 "Modern Power Electronics".

2. The AT is an appendix to the syllabus of the discipline "Modern Power Electronics".

3. Developer: Dmitry A. Kostyukov, Associate Professor of 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:

A.S. Filippov, 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 "Modern Power Electronics".

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-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-4 PC-3 Applies knowledge of the specific features of installation, start-up and commissioning, adjustment, testing, and acceptance into service of various types of electrical power and electrotechnical equipment.	Does not know basic power electronic devices, converter topologies, and commissioning procedures. Cannot interpret converter test results.	Identifies main devices and AC-DC, DC-DC, and DC-AC converters. Performs basic calculations and simple commissioning tasks with reference materials and minor errors.	Correctly selects converter topology, semiconductor devices, PWM/control method, protection, cooling, and EMI/EMC measures. Interprets test results for acceptance.	Independently justifies design and performs commissioning, adjustment, testing, and acceptance of converter systems for renewables, storage, drives, EV charging, and FACTS/HVDC.

ASSESSMENT TOOLS FOR CHECKING THE LEVEL OF COMPETENCY FORMATION

Task No.	Correct Answer	Question Content	Competency
1.	2	Modern power electronics is primarily concerned with: 1) mechanical energy transmission by rotating shafts 2) conversion, control, and conditioning of electrical energy using semiconductor switches 3) design of passive overhead power lines only 4) relay protection without power conversion	PC-3
2.	3	Which device belongs to wide-bandgap power semiconductor technology? 1) electromechanical contactor 2) line-frequency transformer 3) SiC MOSFET 4) oil circuit breaker	PC-3
3.	1	In a controlled thyristor rectifier, the average DC output voltage is mainly regulated by: 1) changing the firing angle of the thyristors 2) changing only the cable length 3) replacing the DC-link capacitor with a fuse 4) grounding the negative DC terminal	PC-3

4.	4	The main function of the DC-link capacitor in many converters is to: 1) measure grid frequency 2) block all switching harmonics at the load terminals 3) replace the gate driver 4) store energy and smooth DC-link voltage ripple	PC-3
5.	1	For an ideal buck converter operating in continuous conduction mode, the output voltage is: 1) $V_{out} = D \times V_{in}$ 2) $V_{out} = V_{in} / (1 - D)$ 3) $V_{out} = -D \times V_{in} / (1 - D)$ 4) $V_{out} = V_{in}$ regardless of duty cycle	PC-3
6.	2	For an ideal boost converter operating in continuous conduction mode, the output voltage is: 1) $V_{out} = D \times V_{in}$ 2) $V_{out} = V_{in} / (1 - D)$ 3) $V_{out} = V_{in} \times (1 - D)$ 4) $V_{out} = 0$ when D is greater than zero	PC-3

7.	3	Discontinuous conduction mode in a DC-DC converter occurs when: 1) the semiconductor switch is permanently open 2) the output voltage is exactly equal to the input voltage 3) the inductor current falls to zero during part of the switching period 4) the converter operates only at line frequency	PC-3
8.	4	A gate-drive system for a power transistor is required to: 1) increase the rated frequency of the grid 2) calculate the mechanical torque of a motor shaft 3) replace all protection circuits in the converter 4) provide proper switching commands, isolation, and protection functions	PC-3
9.	2	Pulse-width modulation (PWM) in a voltage-source inverter is used mainly to: 1) eliminate the need for semiconductor switches 2) synthesize a controlled AC output voltage from a DC link 3) convert AC power into mechanical energy directly 4) measure insulation resistance only	PC-3

10.	1	A key advantage of space-vector PWM compared with simple sinusoidal PWM is: 1) better utilization of the DC-link voltage and flexible switching-state selection 2) operation without a DC source 3) elimination of all switching losses 4) impossibility of overmodulation	PC-3
11.	3	Dead time in inverter bridge legs is introduced to: 1) increase the mass of the heatsink 2) synchronize the converter with GPS time 3) prevent shoot-through of the upper and lower switches, although it can distort the output voltage 4) disconnect the load from the neutral point permanently	PC-3
12.	4	Multilevel converters are widely used in medium- and high-power applications because they: 1) operate only with single-phase loads 2) do not require any semiconductor devices 3) are suitable only for low-voltage laboratory supplies 4) reduce voltage steps, dv/dt stress, and output harmonic distortion	PC-3
13.	2	A modular multilevel converter (MMC) is especially suitable for: 1) incandescent lamp dimming only 2) HVDC transmission, STATCOMs, and high-voltage converter stations 3) replacing all distribution transformers in radial feeders 4) measuring active power with an analog wattmeter	PC-3
14.	1	An active front end (AFE) converter can provide: 1) sinusoidal input current, regulated DC-link voltage, and bidirectional power flow 2) only uncontrolled diode rectification 3) mechanical speed reduction by gears 4) permanent disconnection from the grid	PC-3

15.	3	The main purpose of power factor correction (PFC) in an AC-DC converter is to: 1) increase the rated insulation class of cables 2) prevent all semiconductor aging 3) shape the input current and reduce reactive power and harmonic distortion 4) convert DC power directly into compressed air	PC-3
16.	4	Closed-loop feedback control in a power converter is used to: 1) remove the need for measurements 2) keep the switching device permanently on 3) increase the number of transformer windings only 4) regulate output voltage or current despite input and load variations	PC-3
17.	2	Small-signal modeling of a converter is mainly used for: 1) choosing the color of the converter cabinet 2) designing and evaluating control-loop dynamics and stability margins 3) replacing protection testing 4) calculating the building floor area	PC-3
18.	1	Current-mode control differs from voltage-mode control because it: 1) uses a measured or estimated inductor/switch current signal in the control loop 2) does not require a switching frequency 3) can operate only without feedback 4) is used only for passive filters	PC-3
19.	3	Thermal resistance networks in power electronics are used to estimate: 1) the phase sequence of the grid voltage 2) the communication protocol of an EV charger 3) junction temperature and heat flow from semiconductor devices to the ambient environment 4) the number of turns in a current transformer only	PC-3

20.	4	Snubber circuits in power converters are applied to: 1) replace the control algorithm 2) measure annual energy consumption 3) increase the fundamental frequency of the grid 4) limit voltage overshoot, dv/dt, or switching transients	PC-3
21.	1	Common-mode electromagnetic interference in switching converters is often caused by: 1) high dv/dt switching and parasitic capacitances to ground 2) the absence of any semiconductor devices 3) purely sinusoidal line-frequency current only 4) ideal galvanic isolation with zero capacitance	PC-3
22.	2	An EMI input filter is installed in a converter mainly to: 1) increase mechanical torque without a motor 2) attenuate conducted differential-mode and common-mode noise 3) replace the DC-link capacitor in all cases 4) calculate the state of charge of a battery	PC-3
23.	3	Maximum power point tracking (MPPT) in a photovoltaic converter is used to: 1) set the grid frequency to zero 2) disconnect the PV array during normal operation 3) operate the PV array at the voltage and current that provide maximum available power 4) eliminate the need for a DC-DC stage in every design	PC-3
24.	4	A phase-locked loop (PLL) in a grid-connected converter is used to: 1) measure heatsink temperature only 2) select the enclosure protection class 3) balance the capacitor voltages in a diode bridge only 4) synchronize converter control with the grid voltage phase and frequency	PC-3
25.	2	Grid-connected converters for renewable energy sources must normally provide: 1) uncontrolled operation without measurements 2) controlled current injection, synchronization, protection, and compliance with grid-code requirements 3) mechanical commutation only 4) complete absence of reactive power control	PC-3

26.	1	A bidirectional DC-DC converter in a battery energy storage system is used to: 1) control both charging and discharging power flow between the battery and the DC link 2) convert all AC loads to mechanical loads 3) remove the need for battery management constraints 4) operate only as a passive resistor	PC-3
27.	3	Regenerative braking in an electric drive means that: 1) braking energy is always dissipated only in mechanical friction 2) the inverter is permanently blocked during braking 3) energy from the motor and load can be returned to the DC link, storage system, or grid 4) the drive operates without torque control	PC-3
28.	4	A STATCOM based on voltage-source converter technology is primarily used for: 1) measuring fuel consumption of diesel generators 2) disconnecting all capacitor banks permanently 3) replacing relay protection in transmission lines 4) fast dynamic reactive power compensation and voltage support	PC-3
29.	2	A typical DC fast-charging station for electric vehicles includes: 1) only a passive series resistor connected to the grid 2) an AC-DC front end, DC link, control system, and often an isolated DC-DC charging stage 3) no communication or protection functions 4) a line-frequency motor-generator set only	PC-3
30.	1	Vehicle-to-grid (V2G) technology requires power electronic converters capable of: 1) bidirectional power exchange between the electric vehicle battery and the grid 2) only one-way uncontrolled charging 3) operation without synchronization or protection 4) converting electrical energy directly into hydraulic pressure	PC-3

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.