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Информация о владельце:

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MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution of Higher Education
"NORTH CAUCASUS FEDERAL UNIVERSITY"

APPROVED BY

Acting Director of the Institute

Advanced Engineering

Cand. Tech. Sci., Associate Professor

A.A. Porokhnya

DISCIPLINE ASSESSMENT TOOLS FUND

Advanced Mathematics

Field of study/specialty	11.03.02 Infocommunication Technologies and Communication Systems
Profile	Intelligent Data Processing in Infocommunication Systems and Networks
Year of start of training	2026
Form of study	Full-time
Implemented in a semester	1

Introduction

1. Purpose: conducting current monitoring of progress and intermediate certification in the discipline "Mathematical Analysis".
2. FOS is an appendix to the program of the discipline "Mathematical Analysis".
3. Developer: Andrukhiv L.V., Associate Professor of the Department of Mathematical Modeling, Faculty of Mathematics and Computer Science named after Professor N.I. Chervyakov, Cand. Pedagog. Sciences.
4. An examination of the FAT was carried out.

Members of the expert group:

Chairman: N.Y. Bratchenko, Chairman of the CMT of the Institute of Advanced Engineering, Associate Professor of the Department of Digital, Robotic Systems and Electronics of the Institute of Advanced Engineering.

Members of the Commission:

V.P. Mochalov, Professor of the Department of Digital, Robotic Systems and Electronics of the Institute of Advanced Engineering.

S.V. Melnikov, Senior Researcher of the Interdisciplinary Training and Research Center for Agricultural Technologies, Associate Professor of the Department of Digital, Robotic Systems and Electronics of the Institute of Advanced Engineering.

Representative of the employer's organization:

Mironov V.A., General Director of Orintex LLC.

Expert opinion: The FAT for the discipline allows you to assess the level of competence formation. Start approbation.

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

1. Description of the criteria for assessing competence at various stages of their formation, description of assessment scales

Competency(s), indicator(s)	Levels of competence formation			
	The minimum level has not been reached (Unsatisfactory) 2 points	Minimum level (satisfactory) 3 points	Intermediate level (good) 4 points	High level (excellent) 5 points
GPk-1: Able to apply natural science and general engineering knowledge, methods of mathematical analysis and modeling, theoretical and experimental research in professional activities				
ID-1 _{OPK-1} understands the basics of higher mathematics, physics, the basics of computer technology and programming.	Has difficulty analyzing the content of theoretical questions, does not know the methods of solving practical tasks	Makes serious mistakes in solving practical tasks, has poor theoretical knowledge	Analyzes methods for solving practical tasks, has sufficient theoretical knowledge	Conducts in-depth analysis when solving practical tasks, fully possesses theoretical knowledge
ID-2 _{OPK-1} solves standard professional problems using natural science and general engineering knowledge, methods of mathematical analysis and modeling.	Does not have the skills to apply fundamental knowledge obtained in the field of mathematical sciences and use them in professional activities	Demonstrates poor skills in applying fundamental knowledge gained in the field of mathematical sciences and using it in professional activities	Possesses the skills to apply fundamental knowledge gained in the field of mathematical sciences and use it in professional activities	Fully possesses the skills of applying fundamental knowledge obtained in the field of mathematical sciences and using them in professional activities
ID-3 _{OPK-1} carries out theoretical and experimental research of objects of professional activity.	Does not know how to apply and modify mathematical models to solve problems in the field of professional activity	Demonstrates poor ability to apply and modify mathematical models to solve problems in the field of professional activity	Is able to sufficiently apply and modify mathematical models to solve problems in the field of professional activity	Fully able to apply and modify mathematical models to solve problems in the field of professional activity

Assessment of the level of competence in the discipline is carried out on the basis of the "Regulation on the current monitoring of progress and intermediate certification of students in educational programs of higher education - bachelor's programs, specialist programs, master's

programs - in the Federal State Autonomous Educational Institution of Higher Education "North Caucasus Federal University" in the current edition.

ASSESSMENT TOOLS TO CHECK THE LEVEL OF FORMATION OF COMPETENCIES

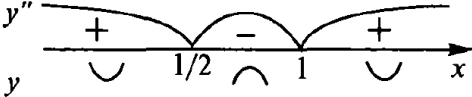
Job Number	Correct answer	Content of the question	Competence
		Semester 1¹	
1.	0,3	Find the limit: $\lim_{x \rightarrow 5} \frac{x^2 - 7x + 10}{x^2 - 25}$	OPK-3
2.	1	Calculate Limit: $\lim_{x \rightarrow \infty} \frac{(x+1)^2}{x^2 + 1}$	OPK-3
3.	a)	Find Function Limit: $\lim_{x \rightarrow \infty} \left(1 + \frac{2}{x}\right)^x$ a) e^2 b) e c) e^{-1} d) e^{-2}	OPK-3
4.	a)	Find the derivative of a y'_x function given implicitly $x^2 + y^2 - 4xy - 10y + 4 = 0$: a) $y' = \frac{2y - x}{y - 2x - 5}$ b) $y' = \frac{x - 2y}{y - 2x - 5}$ c) $y' = \frac{y - 2x - 5}{2y - x}$	OPK-3

¹ Indicated for disciplines implemented in several semesters

		d) $y' = \frac{y-2x-5}{x-2y}$	
5.	$\frac{dx}{x}$	$y = \ln x, \quad dy =$	OPK-3
6.	The first remarkable limit is in the form of a formula: $\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1.$	What is called the first remarkable limit?	OPK-3
7.	Depending on the nature of the behavior of the function in the vicinity of the point of rupture, two main types of discontinuities are distinguished: a rupture of the first kind and a rupture of the second kind. Discontinuity points of the first kind include those points at which there are finite one-sided limits: $\lim_{x \rightarrow x_0-0} f(x) \quad \lim_{x \rightarrow x_0+0} f(x)$ (left limit) and (right limit). Discontinuity points of the second kind are those points at which at least one of the one-sided limits does not exist or is equal to infinity. In turn, the points of discontinuity of the first kind are divided into points of removable discontinuity (when $\lim_{x \rightarrow x_0-0} f(x) = \lim_{x \rightarrow x_0+0} f(x) \neq f(x_0),$ and points of jump (when $\lim_{x \rightarrow x_0-0} f(x) \neq \lim_{x \rightarrow x_0+0} f(x)$	How are function break points classified?	OPK-3

8.	A derived function $y = f(x)$ is the limit of the ratio of the increment of the function to the increment of the argument when the latter tends to zero (provided that this limit exists) $y' = f'(x) = \lim_{\Delta x \rightarrow 0} \frac{\Delta y}{\Delta x} = \lim_{\Delta x \rightarrow 0} \frac{f(x_0 + \Delta x) - f(x_0)}{\Delta x}$.	Define a derived function.	OPK-3
9.	$y' = 4 \left(2x^4 - \frac{3}{\sqrt[3]{x}} + 3 \right)^3 \left(2x^4 - 3x^{-1/3} + 3 \right)' =$ $= 4 \left(2x^4 - \frac{3}{\sqrt[3]{x}} + 3 \right)^3 \left(8x^3 - 3 \cdot \left(-\frac{1}{3} \right) x^{-4/3} + 0 \right) =$ $= 4 \left(2x^4 - \frac{3}{\sqrt[3]{x}} + 3 \right)^3 \left(8x^3 + \frac{1}{x\sqrt[3]{x}} \right).$	Find a derivative of a function: $y = \left(2x^4 - \frac{3}{\sqrt[3]{x}} + 3 \right)^4$.	OPK-3
10.	$y' = e^{4x} (4x)' - 2x' \operatorname{tg} 4x - 2x (\operatorname{tg} 4x)' = 4e^{4x} - 2$ $= 4e^{4x} - 2 \operatorname{tg} 4x - \frac{8x}{\cos^2 4x}.$	Find a derivative of a function: $y = e^{4x} - 2x \operatorname{tg} 4x$.	OPK-3
11.	$y' = \frac{(2xe^{x^2} + x^2 2xe^{x^2})(x^2 + 1) - (2x)x^2 e^{x^2}}{(x^2 + 1)^2} =$ $= \frac{2x^3 e^{x^2} + 2x^5 e^{x^2} + 2xe^{x^2} + 2x^3 e^{x^2} - 2x^3 e^{x^2}}{(x^2 + 1)^2} =$ $= \frac{2xe^{x^2}(x^4 + 1 + x^2)}{(x^2 + 1)^2}$	Find a derivative of a function: $y = \frac{x^2 e^{x^2}}{x^2 + 1}$	OPK-3

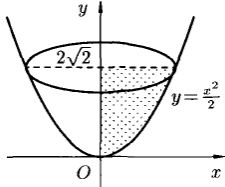
12.	$dy = f'(x)dx = (\arctg 3x)' dx$ $= \frac{3 dx}{1 + (3x)^2}$	Find Function Differential $y = \arctg 3x$.	OPK-3
13.	$y' = \frac{1}{1+x^2}$ $y'' = \frac{-2x}{(1+x^2)^2}$ $y''' = \frac{-2(1+x^2)^2 - 4x(1+x^2)(-2x)}{(1+x^2)^4} = \frac{6x^2 - 2}{(1+x^2)^3}$	Find the 3rd order derivative for the function $y = \arctg x$.	OPK-3
14.	The limit of the ratio of two infinitely small or infinitely large functions is equal to the limit of the ratio of their derivatives (finite or infinite), if the latter exists in the specified sense. Let the functions $f(x)$ and $g(x)$ be differentiable in some neighborhood of the point x_0 (with the exception of the point itself), $f(x_0) = 0$ and $g(x_0) = 0$ (or $\lim_{x \rightarrow x_0} f(x) = \infty$, $\lim_{x \rightarrow x_0} g(x) = \infty$), and $g'(x) \neq 0$ in some neighborhood of the point x_0, then $\lim_{x \rightarrow x_0} \frac{f(x)}{g(x)} = \left\{ \left\{ \frac{0}{0} \right\} \text{ или } \left\{ \frac{\infty}{\infty} \right\} \right\} = \lim_{x \rightarrow x_0} \frac{f'(x)}{g'(x)}$	Formulate L'Hôpital's rule to reveal the uncertainties of the species $\frac{0}{0}, \frac{\infty}{\infty}.$	OPK-3
15.	The points at which the necessary extremum condition for a continuous function is met are called the critical	What points are called critical points of a function?	OPK-3

	points of this function. They are defined from the equation $f'(x) = 0$ (stationary points) or $f'(x) = \infty$.		
16.	If the function $y = f(x)$ has a second derivative (a, b) on the interval and $f''(x) \geq 0$ ($f''(x) \leq 0$) on (a, b) , then the graph of the function has a (a, b) convexity directed downwards (upwards).	Formulate sufficient conditions for the convexity of the graph of the function.	OPK-3
17.	$\lim_{x \rightarrow 1} \frac{x^2 - 1 + \ln x}{e^x - e} = \lim_{x \rightarrow 1} \frac{f'(x)}{g'(x)} = \frac{2x + \frac{1}{x}}{e^x} = \frac{2 + 1}{e}$	Find the limit $\lim_{x \rightarrow 1} \frac{x^2 - 1 + \ln x}{e^x - e}$.	OPK-3
18.	$y' = (x(x-1)^3)' = (x-1)^3 + 3x(x-1)^2 = (x-1)^2(x+2)$ $y'' = ((x-1)^2(4x-1))' = 2(x-1)(4x-1) + (x-1)^2 \cdot 4 = (x-1)(6x-1)$ $y'' = 0$ pri  $x_1 = \frac{1}{2}; \quad x_2 = 1$ Hence $x_1 = \frac{1}{2}; \quad x_2 = 1$ the inflection points of the graph of the function . Function values at inflection points $y\left(\frac{1}{2}\right) = -\frac{1}{16}; \quad y(1) = 0.$	Find the convexity intervals and inflection points of the function plot $y = x(x-1)^3$.	OPK-3

19.	An asymptote of a function graph $y = f(x)$ is a line that has the property that the distance between this line and the graph of the function tends to zero at an unlimited distance from the origin. According to the method of finding, three types of asymptotes are distinguished: vertical $x = a$, horizontal, $y = b$ and oblique $y = kx + b$. A line $x = a$ is a vertical asymptote of a graph of a function $y = f(x)$ if at least one of the one-way limits is equal to infinity $\lim_{x \rightarrow a \pm 0} f(x) = \pm \infty$. The oblique asymptote of the graph of the function is the line given by the equation $y = kx + b$. For its existence, it is necessary that there are finite limits: $k = \lim_{x \rightarrow \infty} \frac{f(x)}{x},$ $b = \lim_{x \rightarrow \infty} (f(x) - kx).$ If at least one of these limits does not exist or is equal to infinity, then the graph does not have a skewed asymptote. In particular, if $k = 0$, then is $y = b$ the equation of the horizontal asymptote. In this case $\lim_{x \rightarrow \infty} f(x) = b$.	Asymptotes of the function graph: concept and types.	OPK-3
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20.	1) The function is defined in intervals: $(-\infty; 0) \cup (0; +\infty)$. Let's check for the vertical asymptote of the point $x = 0$: $\lim_{x \rightarrow 0+0} \frac{x^2 + 2x - 1}{x} = \lim_{x \rightarrow 0+0} \frac{(0+0)^2 + 2(0+0) - 1}{(0+0)} = -\infty$ $\lim_{x \rightarrow 0-0} \frac{x^2 + 2x - 1}{x} = \lim_{x \rightarrow 0-0} \frac{(0-0)^2 + 2(0-0) - 1}{(0-0)} = +\infty$ Therefore, $x = 0$ it is a vertical asymptote. 2) To determine the oblique asymptote, we find the limits: $k = \lim_{x \rightarrow \infty} \frac{x^2 + 2x - 1}{x^2} = 1,$ $b = \lim_{x \rightarrow \infty} (f(x) - x) = \lim_{x \rightarrow \infty} \left(\frac{x^2 + 2x - 1}{x} - x \right) = \lim_{x \rightarrow \infty} \left(\frac{x^2 + 2x - 1 - x^2}{x} \right)$ $= \lim_{x \rightarrow \infty} \left(\frac{2x - 1}{x} \right) = 2.$ Thus, a straight line $y = x + 2$ is an oblique asymptote.	Find the asymptotes of the graph of the function $y = \frac{x^2 + 2x - 1}{x}$.	OPK-3
		Semester 2	
21.	b)	The formula $\int_a^b f(x)dx = F(b) - F(a)$ is called the formula: (a) Cauchy (b) Newton-Leibniz (c) Euler (d) Lagrange	OPK-3

22.	0	$\int_a^a f(x) dx =$	OPK-3
23.	a)	A series is called converging if (a) There is a finite limit to the sequence of its partial sums b) the limit of the common term is equal to zero c) the limit of the modulus of the common term is equal to zero d) the sequence of its partial sums is infinitely large	OPK-3
24.	c)	The series $\sum_{n=1}^{\infty} u_n$ diverges if a) $\lim_{n \rightarrow \infty} u_n = 0$ b) $\lim_{n \rightarrow \infty} u_n \neq \infty$ c) $\lim_{n \rightarrow \infty} u_n \neq 0$ d) $\lim_{n \rightarrow 0} u_n = \infty$	OPK-3
25.	b)	Determine whether this series converges or diverges $\sum_{n=1}^{\infty} \frac{1}{n}$: a) converges b) diverges c) conventionally converges d) absolutely converges	OPK-3
26.	$\int x \cos x dx = \left \begin{array}{ll} u = x & du = dx \\ dv = \cos dx & v = \int \cos dx = \sin x \end{array} \right =$ $= x \sin x - \int \sin x dx =$ $= x \sin x + \cos x + C.$		OPK-3

27.	$\int_0^1 (1 + \sqrt{x})^2 dx = \int_0^1 (1 + 2\sqrt{x} + x) dx = \int_0^1 dx + 2 \int_0^1 x^{\frac{1}{2}} dx + \int_0^1 x dx =$ $= x \Big _0^1 + 2 \cdot \frac{x^{\frac{1}{2}+1}}{\frac{1}{2}+1} \Big _0^1 + \frac{x^2}{2} \Big _0^1 = 1 - 0 + \frac{4}{3} x^{\frac{3}{2}} \Big _0^1 + \frac{1}{2} - 0 = 1 + \frac{4}{3} - 0 + \frac{1}{2}$	Calculate Integral $\int_0^1 (1 + \sqrt{x})^2 dx$	OPK-3
28.	$\int_1^e \frac{\ln^2 x}{x} dx = \begin{cases} \ln x = t \\ \frac{dx}{x} = dt \\ x = 1 \Rightarrow t = 0 \\ x = e \Rightarrow t = 1 \end{cases} = \int_0^1 t^2 dt = \frac{1}{3} t^3 \Big _0^1 = \frac{1}{3} (1^3 - 0^3) = \frac{1}{3}$	Calculate integral $\int_1^e \frac{\ln^2 x}{x} dx$.	OPK-3
29.	$\int_1^2 x^3 \ln x dx = \begin{cases} u = \ln x, & du = \frac{1}{x} dx \\ dv = x^3 dx, & v = \frac{x^4}{4} \end{cases} = \ln x \cdot \frac{x^4}{4} \Big _1^2 - \int_1^2 \frac{x^4}{4} \cdot \frac{1}{x} dx = 4 \ln 2 - \frac{1}{4} \int_1^2 x^3 dx =$ $= 4 \ln 2 - \frac{1}{16} x^4 \Big _1^2 = 4 \ln 2 - 1 + \frac{1}{16} = 4 \ln 2 - \frac{15}{16}$	Calculate Integral $\int_1^2 x^3 \ln x dx$	OPK-3
30.	 $V_y = \pi \int_c^d x^2 dy$ $V_y = \pi \int_0^{2\sqrt{2}} 2y dy = \pi y^2 \Big _0^{2\sqrt{2}} = 8\pi$	Find the volume of a body formed by the rotation of a figure bounded by lines $y = \frac{x^2}{2}$, $x = 0$, $y = 2\sqrt{2}$ around an axis Oy	OPK-3
31.	$\int_1^{+\infty} \frac{dx}{x^2} = \lim_{b \rightarrow +\infty} \int_1^b x^{-2} dx = - \lim_{b \rightarrow +\infty} \frac{1}{x} \Big _1^b = -(0 - 1) = 1$ improper integral converges	Calculate an improper integral or establish its divergence $\int_1^{+\infty} \frac{dx}{x^2}$	OPK-3

32.	According to the condition $u_n = \frac{1}{n!}$, $u_{n+1} = \frac{1}{(n+1)!},$ $d = \lim_{n \rightarrow \infty} \frac{u_{n+1}}{u_n} = \lim_{n \rightarrow \infty} \frac{n!}{(n+1)!} = \lim_{n \rightarrow \infty} \frac{1}{n+1} = 0 < 1$, that is, the series converges.	Investigate the convergence of a series $\sum_{n=1}^{\infty} \frac{1}{n!}$	OPK-3
33.	By condition $u_n = \frac{3^n}{n^5}, u_{n+1} = \frac{3^{n+1}}{(n+1)^5}, \text{ then}$ $d = \lim_{n \rightarrow \infty} \frac{u_{n+1}}{u_n} = \lim_{n \rightarrow \infty} \frac{3^{n+1} \cdot n^5}{(n+1)^5 \cdot 3^n} = 3 \lim_{n \rightarrow \infty} \left(\frac{n}{n+1} \right)^5 = 3 > 1$, the series diverges	Examine the convergence of the series $\sum_{n=1}^{\infty} \frac{3^n}{n^5}$.	OPK-3
34.	By condition $u_n = \left(\frac{2n^2 + 1}{3n^2 + 5} \right)^n$, then, according to Cauchy's radical attribute, $k = \lim_{n \rightarrow \infty} \sqrt[n]{u_n} = \lim_{n \rightarrow \infty} \frac{2n^2 + 1}{3n^2 + 5} = \lim_{n \rightarrow \infty} \frac{2 + \frac{1}{n^2}}{3 + \frac{5}{n^2}} = \frac{2}{3} < 1$, that is, the series converges	Examine the convergence of the series $\sum_{n=1}^{\infty} \left(\frac{2n^2 + 1}{3n^2 + 5} \right)^n$.	OPK-3
35.	Let there be a limit to the relation of $\sum_{n=1}^{\infty} u_n$ the -th term to $(n+1)$ the -th term n for the series with positive terms	What is the hallmark of d'Alembert convergence? When is it advisable to use it?	OPK-3

	$\lim_{n \rightarrow \infty} \frac{u_{n+1}}{u_n} = d$. Then, if $d < 1$, then the series converges; if $d > 1$, then the series diverges. It is advisable to use the d'Alembert criterion when the common term of the series contains an expression of the form $n!$ or a^n. If $\lim_{n \rightarrow \infty} \frac{u_{n+1}}{u_n} = \infty$, then the series diverges. If $d = 1$, then the series can converge, or it can diverge. In this case, the d'Alembert criterion does not give an answer, it is necessary to investigate the convergence of the series with the help of other features.		
36.	If there is a finite or infinite limit $\sum_{n=1}^{\infty} u_n$ for a sign-positive series $\lim_{n \rightarrow \infty} \sqrt[n]{u_n} = k$, then if $k < 1$, then the series converges, if $k > 1$, then the series diverges. If $k = 1$, then the radical attribute does not give an answer about the convergence of the series.	To formulate a radical sign of Cauchy convergence.	OPK-3
37.	An alternating series is understood as a series in which the terms are alternately positive and negative:	Which series is called alternating? What is the Leibniz sign for such a series?	OPK-3

	$u_1 - u_2 + u_3 - u_4 + \dots + (-1)^{n+1} u_n + \dots =$ where $u_n > 0$ for everyone $n \in \mathbb{N}$. For an alternating series, there is a sufficient sign of convergence, which is called the Leibniz sign. If the members of the alternating series: 1) decrease in absolute value $u_1 > u_2 > \dots > u_n > \dots$ and (2) The limit of its common term is $n \rightarrow \infty$ equal to zero, i.e. $\lim_{n \rightarrow \infty} u_n = 0$, then the series converges, and its sum is positive and does not exceed the first term of the series ($0 < S < u_1$).		
38.	A series is said to be absolutely converging if both the series itself and the series composed of the absolute values of its terms converge. A series is called conditionally converging if the series itself converges, and the series composed of the absolute values of its terms diverges.	What is called the absolute convergence of a series? Conditional convergence?	OPK-3
39.	A number R such that for all x, $x < R$, the power series converges, and for all x, $x > R$, diverges, is called the radius of convergence of the series, and the interval $(-R; R)$ is called the interval of convergence.	To give the concept of interval and radius of convergence of a power series	OPK-3

40.	$R = \lim_{n \rightarrow \infty} \left \frac{a_n}{a_{n+1}} \right $ $\lim_{n \rightarrow \infty} \left \frac{a_n}{a_{n+1}} \right = \lim_{n \rightarrow \infty} \left \frac{1}{n!} : \frac{1}{(n+1)!} \right = \lim_{n \rightarrow \infty} (n+1) = \infty$ $R = \infty$, which means that the series converges absolutely for all x, i.e., in the interval $(-\infty, +\infty)$.	Find the radius and interval of convergence of a power series $\sum_{n=1}^{\infty} \frac{x^n}{n!}.$	OPK-3
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Description of the grading scale

Students' progress in each discipline is assessed during current control and intermediate certification.

Criteria for assessing competencies

An *"excellent" grade* is given to a student if the theoretical content of the course is fully mastered, without gaps; exhaustively, consistently, clearly and logically harmoniously presents the material; freely copes with tasks, questions and other types of application of knowledge; uses additional material in the answer all the tasks provided for by the program are completed, the quality of their performance is evaluated by the number of points close to the maximum; analyzes the results obtained; shows independence in completing tasks.

A grade of *"good"* is given to a student if the theoretical content of the course is fully mastered, the necessary practical competencies are basically formed, all the educational tasks provided for by the training program are completed, the quality of their implementation is quite high. The student knows the material firmly, presents it competently and to the point, avoiding significant inaccuracies in answering the question.

The grade *"satisfactory"* is given to the student if the theoretical content of the course is partially mastered, but the gaps are not significant, most of the tasks provided for by the program are completed, but there are errors in them, when answering the question, the student makes inaccuracies, insufficiently correct formulations, there are violations of the logical sequence in the presentation of the program material.

An *"unsatisfactory" grade* is given to a student if he does not know a significant part of the program material, makes significant mistakes, performs practical work unconfidently, with great difficulty, the necessary practical competencies are not formed, most of the educational tasks provided for by the training program are not completed.