Appendix to the working program

Federal State Budgetary Educational Institution of Higher Education
"Privolzhsky Research Medical University"
Ministry of Health of the Russian Federation

BANK OF ASSESSMENT TOOLS FOR DISCIPLINE

«PHYSICS, MATHEMATICS»

Training program (specialty): **31.05.01 GENERAL MEDICINE**

Department: **MEDICAL BIOPHYSICS**

Mode of study: **FULL-TIME**

Nizhniy Novgorod
2021

1. Bank of assessment tools for the current monitoring of academic performance, mid-term assessment of students in the discipline / practice

This Bank of Assessment Tools (BAT) for the discipline " Physics, mathematics " is an integral appendix to the working program of the discipline " Physics, mathematics". All the details of the approval submitted in the WPD for this discipline apply to this BAT.

(Banks of assessment tools allow us to evaluate the achievement of the planned results stated in the educational program.

Assessment tools are a bank of control tasks, as well as a description of forms and procedures designed to determine the quality of mastering study material by students.)

2. List of assessment tools

The following assessment tools are used to determine the quality of mastering the academic material by students in the discipline "Physics, mathematics":

No.	Assessment tool	Brief description of the assessment tool	Presentation of the assessment tool in the BAT
1.	Test №1 Test №2	A system of standardized tasks that allows you to automate the procedure of measuring the level of knowledge and skills of a student.	Bank of test tasks
2.	Situational tasks	A method of control that allows you to assess the criticality of thinking and the degree of the material comprehension, the ability to apply theoretical knowledge in practice.	List of tasks
3.	Individual survey	A control tool that allows you to assess the degree of comprehension of the material	List of questions
4.	Control work	A tool of checking the ability to apply acquired knowledge for solving problems of a certain type by topic or section	Set of control tasks in variants
5.	Colloquium	A tool of controlling the mastering of study materials of a topic, section or sections of a discipline, organized as a class in the form of an interview between a teacher and students.	Questions on topics/sections of the discipline

3. A list of competencies indicating the stages of their formation in the process of mastering the educational program and the types of evaluation tools

Code and formulation of competence*	Stage of competence formation	Controlled sections of the discipline	Assessment tools
UC-1 Able to carry out a critical analysis of problem situations based on a systematic approach, develop an action strategy.	Current	**Section 1.** *Fundamentals of mathematical analysis.*	Situational tasks Individual survey Control work

UC-1 Able to carry out a critical analysis of problem situations based on a systematic approach, develop an action strategy.	Current	**Section 2.** *Fundamentals of probability theory and mathematical statistics.*	Situational tasks Individual survey Control work Colloquium
UC-1 Able to carry out a critical analysis of problem situations based on a systematic approach, develop an action strategy.	Current	**Section 3.** *Mechanics of liquids and gases. Acoustics.*	Situational tasks Individual survey Colloquium
UC-1 Able to carry out a critical analysis of problem situations based on a systematic approach, develop an action strategy.	Current	**Section 4.** *Electrodynamics. Physical processes in tissues when exposed to current and electromagnetic fields. Fundamentals of medical electronics.*	Situational tasks Individual survey Control work Colloquium
UC-1 Able to carry out a critical analysis of problem situations based on a systematic approach, develop an action strategy.	Current	**Section 5.** *Optics. Quantum physics. Ionizing radiation. Basics of dosimetry.*	Situational tasks Individual survey Control work
Credit		***All Sections***	***Credit Test***

4. The content of the assessment tools of entry, current control

Entry /current control is carried out by the discipline teacher when conducting classes in the form of: Test, Situational tasks, Individual survey, Control work, Colloquium.

4.1. Tasks for the assessment of competence "UC-1" *(the competence code):*

PROBABILITY THEORY

Task 1. Calculate the probability that have the numbers 2 or 5 in a trial of the experiment consisting of tossing up the hexahedral dice.

Task 2. Calculate the probability of failure of the following pairs of the three independent electrical batteries (№№ 1, 2, and 3) operating in an electrical circuit: № 1 and № 3, № 2 and№ 3, № 1 and № 3, if the probabilities of the individual failure of the batteries are p(№ 1) = 0.3, p(№ 2) = 0.2 and p(№ 3) = 0.5.

Task 3. There are 11 balls in a box, 2 of them are green, 3 are black, 5 are red and 1 is a blue ball. What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

Task 4. There are 11 balls in a box, 1 of them is a green ball, 5 are black, 3 of them are red and 2 of them are blue. What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

Task 5. There are 21 balls in a box, 12 of them are green, 3 are black, 5 are red and 1 is a blue ball. What is the probability to take a black ball and a green one in two consequent trials, if the black ball is not put back into the box after the first trial?

THE DISTRIBUTIONS OF RANDOM VARIABLES

Task 6. Find the variance and the standard deviation of a random variable, if the random variable has the following distribution law:

x	0,35	0,55	0,77	0,89
p	0,2	0,3	0,3	0,2

Task 7. Find the variance and the standard deviation of a random variable, if the random variable has the following distribution law:

x	5	7	10
p	0,3	0,4	0,3

Task 8. A discrete random variable is represented by the distribution

x	4	2	5
p	0,3	?	0,4

Find the mathematical expectation

Task 9. A discrete random variable is represented by the distribution

	0			1
	,3		,1	,2

Find the mathematical expectation

Task 10. A discrete random variable is represented by the distribution

x	5	7	?
p	0.4	0.2	?

Find the x_3 and p_3, if the mathematical expectation M(X) = 4.6.

Task 11. A discrete random variable is represented by the distribution

	1	5	0	

Find the x_4 and p_4, if the mathematical expectation M(X) = 18.

Task 12. There is another sample of experimental results:

37, 39, 40, 39, 38, 39, 40, 40, 41, 38, 39, 42, 38, 40, 37, 42, 39, 39, 41, 42

a) draw three graphs that characterize the variation series: a frequency polygon, a histogram, and a cumulative curve;

b) calculate the mean value, variance and standard deviation.

Task 13. There is another sample of experimental results:

x_i	3	6	9	12
m_i	9	16	12	8

a) fine the mode;
b) calculate the mean value, variance and standard deviation.

4.2. Control work for the assessment of competence "UC-1":

Fundamentals of mathematical analysis

VARIANT № 1

1.	Find the derivatives	
	$y = x^3 + 2x$	$\boldsymbol{y = \sqrt[3]{x}\, lg\, x}$
2.	Find the differentials	
	$y = x$	$y = \cos x/(3x)$
3.	Find the derivatives (The chain rule)	
	$y = \cos 3x$	$y = \dfrac{1}{(1+\cos 5x)^5}$
4.	Find the total differentials	
	$F = x + z^2$	$F(x, y) = \dfrac{2x+3y^2}{\sqrt[3]{xy}}$
5.	Calculate the indefinite integrals	
	$\int 4x^2 dx$	$\int e^{Cos\, x} Sin\, x dx$
6.	Calculate the definite integrals	
	$\int_0^2 (2x+1)dx$	$\int_4^9 \sqrt{x} dx$
7.	Find the general solution of the differential equations with separable variables	
	$y' + 2 = 0$	$(x+1)dx - 2xydy = 0$
8.	Find the partial solution of the differential equations with separable variables	
	$2y' - x = 0$ $y = 2,\ if\ \ x = -1$	$ydx + cotan\, x\, dy = 0;$ $y = -1,\ if\ \ x = \pi/3$

VARIANT № 2

1.	Find the derivatives	
	$y = 5x^3 + 2x$	$y = \dfrac{1-\sin x}{1+\sin x}$
2.	Find the differentials	

	$y = Sin\ x$	$y = cotan\ x/(2x)$
3.	Find the derivatives (The chain rule)	
	$y = (cos\ x)^4$	$y=\sqrt[3]{4x+\sin 4x}$
4.	Find the total differentials	
	$F = 5\ tan\ x + ln\ y$	$F(x,y)=\ln\left(x^2y^3\right)$
5.	Calculate the indefinite integrals	
	$\int\frac{dx}{x^2}$	$\int x^2\ Sin3x^3dx$
6.	Calculate the definite integrals	
	$\int_0^{\pi} Sinxdx$	$\int_0^{\pi/2} Sinx\ Cos^4x\,dx$
7.	Find the general solution of the differential equations with separable variables	
	$Sin\ x\ dx = -\ dy$	$e^x y` =1$
8.	Find the partial solution of the differential equations with separable variables	
	$xdx - ydy = 0$ $y = 2,\ if\ \ x= 0$	$ydx – tan\ x\ dy = 0;$ $y=1,\ if\ \ x=\pi/6$

<u>VARIANT № 3</u>

1.	Find the derivatives	
	$y = x^4 - 3x^2$	$y=\frac{\ln x-\sqrt[7]{x}}{\sin x}$
2.	Find the differentials	
	$y = Cos\ x$	$y=\sqrt{x}\ cotan\ x$
3.	Find the derivatives (The chain rule)	
	$y = Sin\ 5\ x$	$y=\frac{x^2\sin(x-3)}{\ln x}$
4.	Find the total differentials	
	$F = 7cotan\ x - e^{\ y}$	$F(x,y)=(Sinx^2)\times y^3$
5.	Calculate the indefinite integrals	

	$\int 3^t\,dt$	$\int \frac{\ln^3 x}{x}dx$
6.	Calculate the definite integrals	
	$\int_{-\pi/2}^{\pi/2} Cosxdx$	$\int_0^{\frac{\pi}{2}} Sin^3 x\,Cos\,x\,dx$
7.	Find the general solution of the differential equations with separable variables	
	$e^y y` = 1$	$y'(x+3) = (y+2)$
8.	Find the partial solution of the differential equations with separable variables	
	$Sin\ x\ dx\ -\ dy = 0$ $y = 1,\ if\ \ x=\pi/3$	$y' = cos\ (3x - \pi/4);$ $y=1,\ if\ \ x=\pi/4$

VARIANT № 4

1.	Find the derivatives	
	$y = 1/x^3 + ln\ x$	$y = \frac{x^3 + \sqrt{x}}{e^x}$
2.	Find the differentials	
	$y = tan\ x$	$y = \frac{Sin\,x + \sqrt{x}}{e^x}$
3.	Find the derivatives (The chain rule)	
	$y = (\ Sin\ x)^{\ 5}$	$y = tan\left(ln\,x^2\right) \times e^x$
4.	Find the total differentials	
	$F = 5\ tan\ x + 2e^{\ y}$	$F(x,y) = (Sin\,x^5)\ /\ y^2$
5.	Calculate the indefinite integrals	
	$\int \frac{dx}{2x^3}$	$\int \frac{\sqrt{1+\ln x}}{x}dx$
6.	Calculate the definite integrals	
	$\int_0^1 \sqrt[3]{x}$	$\int_1^2 \frac{2x^2+1}{x}dx$
7.	Find the general solution of the differential equations with separable variables	
	$5tan\ x\ dx - dy = 0$	$(1+y^2)\ \ dx\ \ -\ \ \sqrt{x}\ \times ydy\ = 0$
8.	Find the partial solution of the differential equations with separable variables	

	$(x^2 + 4x)dx = dy$ $y = 3$, if $x = 0$	$(1+y)dx - (1-x)\,dy = 0;$ $y=3$, if $x=0,5$

VARIANT № 5

1.	Find the derivatives	
	$y = \log_7 x + e^x$	$y = \dfrac{e^x}{\lg x + 2x}$
2.	Find the differentials	
	$y = \cot an\, x$	$y = \sqrt[3]{x}\,\lg x$
3.	Find the derivatives (The chain rule)	
	$y = (\tan x)^5$	$y = \cos(\sqrt{1+\sin^2 x})$
4.	Find the total differentials	
	$F = 3\cot an\, x - 5\ln y$	$F(x,y,z) = \dfrac{x^4}{\sqrt{yz}}$
5.	Calculate the indefinite integrals	
	$\int \sqrt[3]{t}\,dt$	$\int Cos^5 x \times Sin\, x dx$
6.	Calculate the definite integrals	
	$\int_4^9 \sqrt{x}dx$	$\int_0^{\frac{\pi}{2}} (Sin\, x^3)\; x^2\; dx$
7.	Find the general solution of the differential equations with separable variables	
	$4x - 3y^2 y\grave{} = 0$	$y' = 2\cos(2x + 3)$
8.	Find the partial solution of the differential equations with separable variables	
	$5\tan x\, dx - dy = 0$ $y = 5$, if $x = 0$	$y' + y\tan x = 0;$ $y=2$, if $x=0$

VARIANT № 6

1.	Find the derivatives	
	$y = \lg x + x^5$	$y = \ln x\,\dfrac{x^4}{7}$
2.	Find the differentials	

	$y = x^6 + 3x^3 - 10$	$y = \dfrac{\tan x + x^2}{\cos x}$
3.	Find the derivatives (The chain rule)	
	$y = \ln(x-2)$	$y = \sqrt[5]{(4x^2 - 3x + 1)^3}$
4.	Find the total differentials	
	$F(x,t) = x^2 + t - 5$	$F(x,y,t) = \dfrac{xy^2}{t^3}$
5.	Calculate the indefinite integrals	
	$\int \dfrac{5dt}{t^3}$	$\int Sin^5 x\, Cos\, x\, dx$
6.	Calculate the definite integrals	
	$\int_0^{\pi} Sinx dx$	$\int_0^4 \dfrac{x\,dx}{\sqrt{x^2+9}}$
7.	Find the general solution of the differential equations with separable variables	
	$y` - x = 5x^4$	$y' = \cos x \times cotan\, y$
8.	Find the partial solution of the differential equations with separable variables	
	$y' = 2xy$ $y = e$, if $x = -3$	$y' = y \times Sin\, x$ $y = 1$, if $x = \pi$

VARIANT № 7

1.	Find the derivatives	
	$y = 3x^2 + 7^x + 5$	$y = lg\, x \times ln\, x$
2.	Find the differentials	
	$y = x^2 Sin\, x$	$y = \dfrac{\sin x - \cos x}{\sqrt[3]{x}}$
3.	Find the derivatives (The chain rule)	
	$y = ln(x^3)$	$y = \ln cotan(x+1)$
4.	Find the total differentials	
	$F(x,z,t) = ln\, x + z \times t$	$F(x,y,z) = \dfrac{x^5 y^2}{z^4}$

5.	Calculate the indefinite integrals	
	$\int (3x^2 + 2x - 1)dx$	$\int \frac{\ln x + 5}{x} dx$
6.	Calculate the definite integrals	
	$\int_{-\pi/2}^{\pi/2} Cosxdx$	$\int_{\frac{\pi}{2}}^{\pi} \frac{Sin\, x\, dx}{(1 - Cos\, x)^2}$
7.	Find the general solution of the differential equations with separable variables	
	$dy + 3ydx = 0$	$yy' = \sin x + \cos x$
8.	Find the partial solution of the differential equations with separable variables	
	$y' cotan\, x = 1$ $y = 7$, if $x = 0$	$ydx + cotan\, x\, dy = 0;$ $y = 1$, if $x = \pi/3$

VARIANT № 8

1.	Find the derivatives	
	$y = 3\ln x + \lg x + 4x$	$y = \frac{\sqrt{x} + \lg x}{\cos x}$
2.	Find the differentials	
	$y = \lg x + \frac{4}{\sqrt[4]{x}}$	$y = \frac{\sqrt{x} + \lg x}{\cos x}$
3.	Find the derivatives (The chain rule)	
	$y = \ln(\ln x)$	$y = \sin \lg(x^2)$
4.	Find the total differentials	
	$F(x,u) = \frac{u^3 \times x^5}{4}$	$F(x,y) = \ln cotan(xy)$
5.	Calculate the indefinite integrals	
	$\int \frac{dx}{2x^3}$	$\int \frac{Cos\, 2x}{1 + Sin\, 2x}$
6.	Calculate the definite integrals	
	$\int_{-\pi/2}^{\pi/2} 2Cosxdx$	$\int_{5}^{1} \frac{t\, dt}{\sqrt{5 + 4t^2}}$

7.	Find the general solution of the differential equations with separable variables	
	$yy` = 3x^2+8x$	$y'(x+3) = (y+2)$
8.	Find the partial solution of the differential equations with separable variables	
	$2xyy' = 5;$ $y = 4\ ,\ if\ \ x = 1$	$\cos x \sin y\, dy - \cos y \sin x\, dx = 0;$ $y = \pi/4,\ if\ \ x = \pi/3$

VARIANT № 9

1.	Find the derivatives	
	$y = 2x^4 + 1/x + 3x$	$y = x^{\frac{2}{3}} \times \dfrac{\sin x}{2}$
2.	Find the differentials	
	$\mathrm{y = lg\, x} + \dfrac{4}{\sqrt[4]{\mathrm{x}}}$	$y = \dfrac{x^3 - 2e^x}{\sqrt{x}}$
3.	Find the derivatives (The chain rule)	
	$y = ln\ (\ x^4\ )$	$y = \boldsymbol{ln(}\ e^{\frac{2}{5}x} + \sqrt{x}\ \boldsymbol{)}$
4.	Find the total differentials	
	$F(x,u) = \dfrac{2u^3 \times x^4}{3}$	$F(x,y) = \dfrac{\sin 2x^2 y^3}{e^{xy}}$
5.	Calculate the indefinite integrals	
	$\int (3x^2 \quad - 2Cosx)dx$	$\int \sqrt{2x^2+1}\ x\,dx$
6.	Calculate the definite integrals	
	$\int\limits_0^\pi \tan x\, dx$	$\int\limits_{\frac{\pi}{2}}^{\pi} \dfrac{Sin\, x\, dx}{(1 - Cos\, x)^2}$
7.	Find the general solution of the differential equations with separable variables	
	$yy` = 5x^4+6x+7$	$y' = 2\cos(2x + 3)$
8.	Find the partial solution of the differential equations with separable variables	
	$xdy = ydx;$ $y = 8\ ,\ if\ \ x = 2$	$2(1 + e^x)yy' = e^x;$ $y = 0,\ if\ \ x = 0$

VARIANT № 10

1.	Find the derivatives	
	$y = 3/x^3 + 5x$	$y = \dfrac{2x^4 - 4x^2}{3\ln x}$
2.	Find the differentials	
	$y = \dfrac{x^3}{3} - 2x^2 + 4x - 5$	$y = \dfrac{3 - \sqrt[3]{x}}{\sqrt[3]{x} + 3}$
3.	Find the derivatives (The chain rule)	
	$y = Sin\,(3x^3)$	$y = \dfrac{x^2 \sin(x-3)}{\ln x}$
4.	Find the total differentials	
	$F(x,y,t) = x^6 y^2 t$	$F(x,y) = \dfrac{xy^2 - 3x^2}{\sqrt{xy}}$
5.	Calculate the indefinite integrals	
	$\int (4x^3 - 2Sinx)dx$	$\int \dfrac{dx}{x\sqrt{1-\ln x}}$
6.	Calculate the definite integrals	
	$\int_{-\pi/2}^{\pi/2} cotan\,x\,dx$	$\int_{\frac{\pi}{4}}^{\frac{\pi}{2}} \dfrac{Cos\,x\,dx}{Sin^3 x}$
7.	Find the general solution of the differential equations with separable variables	
	$yy\text{\`{}} = 8x^7 + 5x + 10$	$3y\,dx = 2\sqrt{x}\,dy$
8.	Find the partial solution of the differential equations with separable variables	
	$y\text{\`{}} = (Sinx + Cos\,x);$ $y = 3$, if $x = \pi$	$y\,dx + cotan\,x\,dy = 0;$ $3\,y = -1$, if $x = \pi/3$

Fundamentals of probability theory and mathematical statistics

Variant № 1

1. Find conditional probability of the event:
There are 10 balls in a box, 2 of them are green, 3 of them are black, 3 of them are red and 2 of them are blue.

What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

2. Draw the distribution of probabilities to find m = 0,1,2,3,4 healthy patients in the group of 4 participants of this experiment, when the probability to have this disease is 0.2.

3. Estimate the error of indirect measurement, here Q is result of the indirect measurement and the scores υ and S represent the results of the direct measurements:

$$Q = \upsilon * S$$

$\upsilon_1 = 5$ m/s, $\upsilon_2 = 6$ m/s, $\upsilon_3 = 6$ m/s, $\upsilon_4 = 5$ m/s, $\Delta\upsilon_{in} = 0.01$ m/s
$S_1 = 12\ m^2$, $S_2 = 13\ m^2$, $S_3 = 11\ m^2$, $S_4 = 10\ m^2$, $\Delta S_{in} = 0.2\ m^2$
Confidence probability $\alpha = 0.95$.

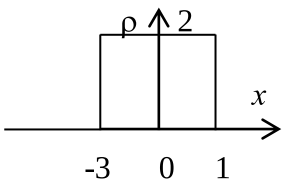
4. *Find*: mean (***M***), variance (***D***), standard deviation (S_x) for the discrete variable

x	5	7	10
p	0.3	0.4	0.3

5. *Find*: the unknown variable and probability, if mean (M) equal to 10.8

x	12	x_2	9	11	13
p	0.2	0.2	0.3	p_4	0.2

6. *Find*: mean (***M***), variance (***D***), standard deviation (S_x) for the continuous variable



7. The normal distribution (the properties, the formula, the parameters of the distribution, the graph); the standard distribution.
The standard intervals and confidence probabilities; 1 - σ rule, 2 - σ rule, 3 - σ rule.

Variant № 2

1. Find conditional probability of the event:
There are 11 balls in a box, 1 of them are green, 1 of them are black, 2 of them are red and 7 of them are blue.

What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

2. Calculate the probabilities to find 0, 1, 3 and 4 healthy patients among the group of 4 participants and create a chart, demonstrating the distribution of the probabilities (here probability of the disease is 0,2).

3. Estimate the error of indirect measurement, here F is result of the indirect measurement and the scores m, r and ν represent the results of the direct measurements:

$$F = \omega^2 * m * r:$$

m_1 = 10.0g, m_2 = 10.2g, m_3 = 10.1g
r_1 = 0,12 m, r_2 = 0,13 m, r_3 = 0,11 m
$\nu = 10^3$ Hz – Const ($\omega=2\pi\nu$)
$\Delta m_{in} = 5*10^{-4}$ kg, $\Delta r_{in} = 10^{-3}$ m
Confidence probability α = 0.95.

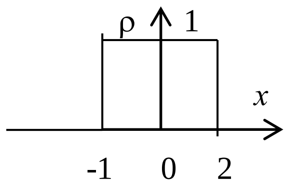
4. <u>*Find*</u>: mean (***M***), variance (***D***), standard deviation (S_x) for the discrete variable

x	0.6	0.5	0.7
p	0.2	0.5	0.3

5. <u>*Find*</u>: the unknown variable and probability, if mean (M) equal to 15.2

x	14	x_2	13	15	17
p	0.2	0.2	0.3	p_4	0.2

6. <u>*Find*</u>: mean (***M***), variance (***D***), standard deviation (S_x) for the continuous variable



7. Binomial distribution (the properties, the formula, the parameters of the distribution, the graph). Poisson distribution (the properties, the formula, the parameters of the distribution, the graph).

<u>Variant № 3</u>

1. Find conditional probability of the event:
There are 21 balls in a box, 1 of them are red, 1 of them are blue, 10 of them are green and 9 of them are black.

What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

2. Calculate the probabilities to take out 0, 1, 3 and 4 independent trials if the urn contains 8 blue balls and 4 green balls (a ball is put back into the urn after each trial) and create a chart, demonstrating the distribution of the probabilities.

3. Estimate the error of indirect measurement, here Q is result of the indirect measurement and the scores I, R, and t represent the results of the direct measurements:

$$Q = I^2 * R * t, \text{ где:}$$

I_1 = 5,0 A , I_2 = 5.2 A, I_3 = 5.1 A
R_1 = 12,4 Ω, R_2 =12,2 Ω, R_3 =12,3 Ω
t_1 = 10.0 s, t_2 = 10.1 s, t_3 = 10.5 s
$\Delta I_{пр}$ = 0.3 A, ΔR_{in}= 0.12 Ω , Δt_{in}=0.01 s
Confidence probability α = 0.98.

4. <u>*Find*</u>: mean (***M***), variance (***D***), standard deviation (S_x) for the discrete variable

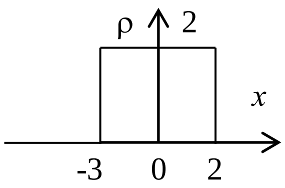
x	4.4	5.3	8.1	9.6

p	0.2	0.3	0.4	0.1

5.<u>*Find*</u>: the unknown variable and probability, if mean (M) equal to 3.9

x	4	x_2	3	5	7
p	0.2	0.3	p_3	*0.3*	0.1

6.<u>*Find*</u>: mean (***M***), variance (***D***), standard deviation (S_x) for the continuous variable



7. Enumerate and explain the statistical meaning of parameters of parent population and characteristics of a sample. Set up conformance between the population parameters and characteristics of a sample.

<u>Variant № 4</u>

1. Find conditional probability of the event:
There are 12 balls in a box, 2 of them are green, 4 of them are black, 1 of them are red and 5 of them are blue.

What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

2. Draw the probability distribution of $P_n(m)$ to take 0,1,2,3,yellow balls in 5 trials (the box contains 8 yellow and 8 green balls).

3. Estimate the error of indirect measurement, here ε is result of the indirect measurement and the scores L and I represent the results of the direct measurements:

$$\varepsilon = L \times I^2/2$$

$L_1 = 0.3$ H, $L_2 = 0.4$ H, $L_3 = 0.4$ H, $L_4 = 0.5$ H
$I_1 = 1{,}2$ A, $I_2 = 1{,}3$ A, $I_3 = 1{,}1$ A, $I_4 = 1{,}0$ A
$\Delta L_{in} = 0.01$ H, $\Delta I_{in} = 0.2$ A
Confidence probability $\alpha = 0.95$.

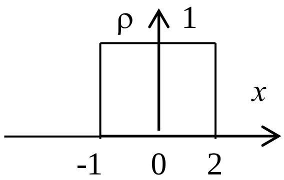
4. <u>*Find*</u>: mean (***M***), variance (***D***), standard deviation (S_x) for the discrete variable

x	0.35	0.55	0.77	0.89
p	0.2	0.3	0.3	0.2

5. <u>*Find*</u>: the unknown variable and probability, if mean (M) equal to 5.0

x	3	x_2	6	5	7
p	0.1	0.3	p_3	*0.2*	0.1

6. <u>*Find*</u>: mean (***M***), variance (***D***), standard deviation (S_x) for the continuous variable



7. Kinds of errors of measurements. Define possible sources for all of error`s types. The methods of elimination of crude and systematic errors; the examples.

<u>Variant № 5</u>

1. Find conditional probability of the event:
There are 18 balls in a box, 3 of them are green, 4 of them are black, 5 of them are red and 6 of them are blue.

What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

2. Draw the probability distribution of $P_n(m)$ to take 0,1,2,3,4 yellow balls in 5 trials (the box contains 8 yellow and 8 green balls).

3. Estimate the error of indirect measurement, here p is result of the indirect measurement and the scores ρ, c and υ represent the results of the direct measurements:

$$p = \rho * c * \upsilon$$

$\rho_1 = 10.2$ kg/m^3 , $\rho_2 = 10.4$ kg/m^3, $\rho_3 = 10.3$ kg/m^3
$\upsilon_1 = 2.0$ m/s , $\upsilon_2 = 2.0$ m/s, $\upsilon_3 = 2.3$ m/s
c = 330 м/c - Const
$\Delta \rho_{in} = 0.13$ kg/m^3, $\Delta\upsilon_{in} = 0.2$ m/s.
Confidence probability $\alpha = 0.95$.

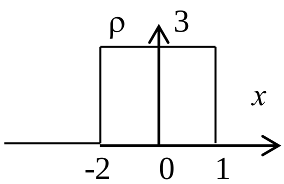
4. <u>*Find*</u>: mean (***M***), variance (***D***), standard deviation (S_x) for the discrete variable

x	1.7	4.5	6.1	7.0
p	0.2	0.3	0.3	0.2

5.<u>*Find*</u>: the unknown variable and probability, if mean (M) equal to 3.8

x	3	1	6	x_4	7
p	0.2	p_2	0.2	*0.2*	0.1

6.<u>*Find*</u>: mean (***M***), variance (***D***), standard deviation (S_x) for the continuous variable



7. The normal distribution (the properties, the formula, the parameters of the distribution, the graph); the standard distribution.
The standard intervals and confidence probabilities; 1 - σ rule, 2 - σ rule, 3 - σ rule.

<u>Variant № 6</u>

1. Find conditional probability of the event:
There are 12 balls in a box, 3 of them are green, 2 of them are black, 3 of them are red and 4 of them are blue.

What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

2. Find the probability to diagnose the disease "D" in 2 patients per day in the group of 292 participants, if the disease is diagnosed in 7 patients per year.

3. Estimate the error of indirect measurement, here Q is result of the indirect measurement and the scores *I*, *R* and *t* represent the results of the direct measurements:

$$Q = I^2 \times R \times t$$

$I_1 = 4{,}0$ A , $I_2 = 4.2$ A, $I_3 = 4.1$ A
$R_1 = 11{,}4\ \Omega$, $R_2 = 11{,}2\ \Omega$, $R_3 = 11{,}3\ \Omega$
$t_1 = 9.0$ s, $t_2 = 9.1$ s, $t_3 = 9.5$ s
$\Delta I_{in} = 0.09$ A, $\Delta R_{in} = 0.11\Omega$, $\Delta t_{in} = 0.01$ s
Confidence probability $\alpha = 0.98$.

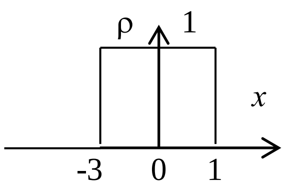
4. *Find*: mean (***M***), variance (***D***), standard deviation (S_x) for the discrete variable

x	1.6	1.2	1.6	2.3	1.5
p	0.2	0.1	0.3	0.2	0.2

5. *Find*: the unknown variable and probability, if mean (M) equal to 6.6

x	x_1	8	5	6	7
p	p_1	0.3	0.2	0.1	0.2

6. *Find*: mean (***M***), variance (***D***), standard deviation (S_x) for the continuous variable



7. Binomial distribution (the properties, the formula, the parameters of the distribution, the graph). Poisson distribution (the properties, the formula, the parameters of the distribution, the graph).

Variant № 7

1. Find conditional probability of the event:
There are 20 balls in a box, 4 of them are green, 5 of them are black, 8 of them are red and 3 of them are blue.

What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

2. Draw the probability distribution of $P_n(m)$ to take 0,1,2,3,4 yellow balls in 5 trials (the box contains 7 yellow and 7 green balls).

3. Estimate the error of indirect measurement, here p is result of the indirect measurement and the scores ω, S and υ represent the results of the direct measurements:

$$\Phi = \omega \times S \times \upsilon$$

$\upsilon_1 = 3$ m/s, $\upsilon_2 = 4$м/с, $\upsilon_3 = 4$ m/s, $\upsilon_4 = 5$ m/s
$S_1 = 1{,}2\ m^2$, $S_2 = 1{,}3\ m^2$, $S_3 = 1{,}1\ m^2$, $S_4 = 1{,}0\ m^2$
$\omega_1 = 20\ W/m^3$, $\omega_2 = 22\ W/m^3$, $\omega_3 = 21\ W/m^3$
$\Delta\upsilon_{in} = 0.01$ m/s, $\Delta S_{in} = 0.2\ m^2$, $\Delta\omega_{in} = 0.02\ W/m^3$
Confidence probability $\alpha = 0.95$.

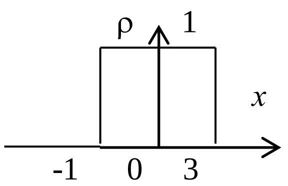
4. *Find*: mean (***M***), variance (***D***), standard deviation (S_x) for the discrete variable

x	1.75	1.81	1.79	1.84
p	0.3	0.2	0.2	0.3

5. *Find*: the unknown variable and probability, if mean (M) equal to 6.5

x	x_1	8	5	6
p	p_1	0.3	0.3	0.2

6. *Find*: mean (***M***), variance (***D***), standard deviation (S_x) for the continuous variable



7. Enumerate and explain the statistical meaning of parameters of parent population and characteristics of a sample. Set up conformance between the population parameters and characteristics of a sample.

Variant № 8

1. Find conditional probability of the event:
There are 17 balls in a box, 3 of them are green, 4 of them are black, 7 of them are red and 3 of them are blue.

What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

2. Draw the probability distribution of $P_n(m)$ to take 0,1,2,3,4 yellow balls in 4 trials (the box contains 6 yellow and 8 green balls).

3. Estimate the error of indirect measurement, here Q is result of the indirect measurement and the scores υ and S represent the results of the direct measurements:

$$Q = \upsilon * S$$

$\upsilon_1 = 10$ m/s, $\upsilon_2 = 9$ m/s, $\upsilon_3 = 11$ m/s, $\upsilon_4 = 12$ m/s, $\Delta\upsilon_{in} = 0.1$ m/s
$S_1 = 8\ m^2$, $S_2 = 9\ m^2$, $S_3 = 7\ m^2$, $S_4 = 8\ m^2$, $\Delta S_{in} = 0.01\ m^2$
Confidence probability $\alpha = 0.98$.

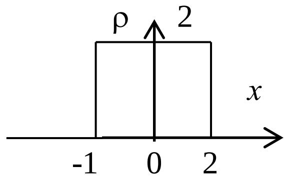
4. *Find*: mean (***M***), variance (***D***), standard deviation (S_x) for the discrete variable

x	0.9	1.1	0.8	0.7
p	0.1	0.4	0.3	0.2

5. *Find*: the unknown variable and probability, if mean (M) equal to 0.79

x	0.7	0.8	x_3	0.6
p	p_1	0.3	0.3	0.2

6. *Find*: mean (***M***), variance (***D***), standard deviation (S_x) for the continuous variable



7. Kinds of errors of measurements. Define possible sources for all of error`s types. The methods of elimination of crude and systematic errors; the examples.

Variant № 9

1. Find conditional probability of the event:
There are 12 balls in a box, 3 of them are green, 2 of them are black, 3 of them are red and 4 of them are blue.

What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

2. Find the probability to diagnose the disease "D" in 2 patients per day in the group of 292 participants, if the disease is diagnosed in 7 patients per year.

3. Estimate the error of indirect measurement, here Q is result of the indirect measurement and the scores *I, R* and *t* represent the results of the direct measurements:

$$Q = I^2 \times R \times t$$

$I_1 = 4{,}0$ A , $I_2 = 4.2$ A, $I_3 = 4.1$ A
$R_1 = 11{,}4\ \Omega$, $R_2 = 11{,}2\ \Omega$, $R_3 = 11{,}3\ \Omega$
$t_1 = 9.0$ s, $t_2 = 9.1$ s, $t_3 = 9.5$ s
$\Delta I_{in} = 0.09$ A, $\Delta R_{in} = 0.11\Omega$, $\Delta t_{in} = 0.01$ s
Confidence probability $\alpha = 0.98$.

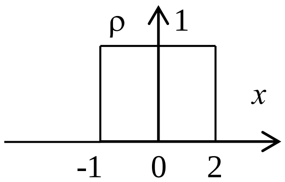
4. *Find*: mean (***M***), variance (***D***), standard deviation (S_x) for the discrete variable

x	0.51	0.55	0.67
p	0.3	0.5	0.2

5. *Find*: the unknown variable and probability, if mean (M) equal to 15.2

x	14	x_2	13	15	17
p	0.2	0.2	0.3	p_4	0.2

6. *Find*: mean (***M***), variance (***D***), standard deviation (S_x) for the continuous variable



7. The normal distribution (the properties, the formula, the parameters of the distribution, the graph); the standard distribution.
The standard intervals and confidence probabilities; 1 - σ rule, 2 - σ rule, 3 - σ rule.

<u>Variant № 10</u>

1. Find conditional probability of the event:
There are 17 balls in a box, 3 of them are green, 4 of them are black, 7 of them are red and 3 of them are blue.

What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

2. Draw the probability distribution of $P_n(m)$ to take 0,1,2,3,4 yellow balls in 4 trials (the box contains 6 yellow and 8 green balls).

3. Estimate the error of indirect measurement, here Q is result of the indirect measurement and the scores υ and S represent the results of the direct measurements:

$$Q = \upsilon * S$$

$\upsilon_1 = 10$ m/s, $\upsilon_2 = 9$ m/s, $\upsilon_3 = 11$ m/s, $\upsilon_4 = 12$ m/s, $\Delta\upsilon_{in} = 0.1$ m/s
$S_1 = 8\ m^2$, $S_2 = 9\ m^2$, $S_3 = 7\ m^2$, $S_4 = 8\ m^2$, $\Delta S_{in} = 0.01\ m^2$
Confidence probability $\alpha = 0.98$.

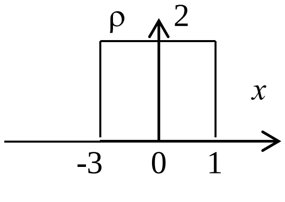
4. <u>*Find*</u>: mean (***M***), variance (***D***), standard deviation (S_x) for the discrete variable

x	9	11	10
p	0.4	0.4	0.2

5. <u>*Find*</u>: the unknown variable and probability, if mean (M) equal to 10.8

x	11	x_2	9	10	12
p	0.3	0.1	0.3	p_4	0.1

6. <u>*Find*</u>: mean (***M***), variance (***D***), standard deviation (S_x) for the continuous variable



7. Binomial distribution (the properties, the formula, the parameters of the distribution, the graph).
Poisson distribution (the properties, the formula, the parameters of the distribution, the graph).

4.3. Questions for colloquiums *(the competence code UC-1):*

Questions for colloquium «*Mechanics of liquids and gases*».

1. Surface tension. Surfactants and surfactants. The phenomenon of capillarity. Gas embolism.

2. Phenomena of wetting, non-wetting, ideal wetting, edge angle. Hydrophilic and hydrophobic surfaces.

3.The equation of continuity of the jet. The Bernoulli equation. The Torricelli formula. Methods of measuring statistical, dynamic and total pressure.

4. The total pressure in the flow of the ideal liquid. A method for measuring static pressure and fluid flow velocity using pressure gauge tubes.

5. The concepts of stationary flow are laminar and turbulent flows. Lines, current surfaces (layers). Reynolds number. The critical value of the Reynolds number. Kinematic viscosity coefficient. Turbulence in the cardiovascular system.

6. Viscosity. Newton's formula. The viscosity coefficient. Newtonian and non-Newtonian fluids, examples. Blood flow rates in various departments of the Cardiovascular System (give a graph, explain qualitatively from the point of view of the continuity equation of the jet).

7. Laws of viscous fluid flow. Poiseuille formula, hydraulic resistance. The flow of viscous liquid through pipes (sequential and parallel connection of pipes). To draw an analogy with Ohm's law for a section of the chain.

8. Serial connection of the tubes, two conditions. Derive the formula for the hydraulic connection of series-connected tubes.

9. Parallel connection of the tubes, two conditions. Deduce the formula for the hydraulic connection of parallel connected tubes.

10. Methods for the determination of viscous liquid. Capillary method, Hess method, rotational viscometry. Types of viscometers, the principle of their operation. The concept of relative viscosity.

11. The phenomenon of a decrease in equivalent viscosity in small vessels. The Caisson equation. Theory of the cutting cylinder. "Coin column."

12. Stokes' law. Derive the formula for the viscosity of the liquid, the relationship of dynamic and kinematic viscosities.

13. Newton's equation. Newtonian and non-Newtonian fluids corresponding to their viscosities. Examples.

14. Describe the principle of pressure measurement by the "Korotkov Sounds" method.

15. Pulse waves, graphs of pressure fluctuations near the heart and in arterioles. Pulse wave length. Equation for pressure wave, pulse wave velocity

16. The work and power of the heart, the principle of operation of the artificial circulation apparatus.

Questions for colloquium «*Ionizing radiation. Basics of dosimetry*.».

l. What is ionizing radiation? Enumerate the kinds ionizing radiations and explain what is the constitution of each of them.

2.Interaction of ionizing radiation with matter. Absorption of photons with a homogeneous matter (exponential law); types (branches) of reactions of photons with atoms.

3.Coefficient of attenuation of X- and γ- radiation as a function of photon energy.

4.Enumerate the main stages of interaction of an ionizing particle with matter and explain what are a) elementary track volume, b)track of an ionizing particle.

5.Interaction of ionizing radiation with matter. Absorption of electrically charged ionizing particles in matter. Stopping power. Range.

6. What do you understand by biological effects of ionizing radiation?

7.What kinds of detectors of ionizing particles do you know? What are physical properties of these detectors?

8.Sketch a simple end-window Geiger tube and explain what are the main principles of operation a Geiger counter.

9.Explain the meaning of the words *scintillation materials.* Sketch a scintillation detector composition and explain the main principles of operation of scintillation detectors.

10.Sketch a diagram characterizing a photomultiplier tube composition, and explain it.

11.What do you understand by a) atomic nucleus, b) atomic (proton) number, c) radioactive decay, d) half-life time (what is its correlation with the decay constant?), e) activity of radioactive isotopes? What are units of activity?

12. Explain the law of radioactive decay. What do you understand by the methods of measurement of short and long half-life and by carbon dating?

13. What kinds of radioactive doses do you know? What do you understand by the quality factor?

14. What do you know about the typical radiation doses from the natural and the artificial sources? What is the most significant natural source of background radiation? What is the most significant artificial source of background radiation?

4.4. Tasks (assessment tools) for the credit *(the competence code UC-1):*

MATHEMATICS

DIFFERENTIAL CALCULUS

PROBLEMS

I. Calculate the derivative of the product of functions

1. $y=\frac{x^2}{2}\cdot\cos x$	6. $y = Sin\ x \cdot Cos\ x$
2. $y=\sqrt[3]{x}\cdot lg x$	7. y = $x \cdot ln\ x$
3. $y=ln x\cdot tg\ x$	8. $y = Cos\ x \cdot ln\ x$
4. $y=e^x Sinx$	9. y = $log_a x \cdot Sin\ x$
5. $y=\sqrt{x}\cdot ctg\, x$	10. $y=a^x\cdot\sqrt[3]{x}$

II. Calculate the derivative of a fraction

1. $y=\frac{tg\, x+x^2}{\cos x}$	3. $y=\frac{4x^3-lg\, x}{4}$
2. $y=\frac{1-Sinx}{1+Sinx}$	4. $y=\frac{x^2-4}{x^2+4}$

III. Find derivatives of the following functions

1. $y=x+3x^2-\frac{x^3}{3}$	5. $y=\left(\sqrt{x}-\sqrt{a}\right)^2$
2. $y=\frac{x^3}{3}-2x^2+4x-5$	6. $y=x^6+3x^3-10$

3. $y = 5Sinx + ln\,x$	7. $y = \frac{x^3}{3} - 2\sqrt{x} + \frac{1}{x} + 2$
4. $y = \sqrt[7]{x} - \frac{tgx}{3}$	8. $y = \frac{1}{x} + \frac{1}{x^2} + a^x$

IV. Calculate the differentials of the following functions

1. $y = \frac{Sinx - Cosx}{\sqrt[3]{x}}$	4. $y = e^{-(1/x)}$
2. $y = \frac{x^3 + \sqrt{x}}{e^x}$	5. $y = \sqrt{x}\ tg\,x$
3. $y = \frac{x^3}{x^2 + 1}$	6. $y = \sqrt[3]{Sin2x}$

V. Find partial derivatives of functions with respect to independent variables

1. $f(x,z) = Sinx - Cosz$	4. $f(x,z,t) = ln\,x(z + t)$
2. $f(x,t) = x^2 + t - 5$	5. $f(x,u,t) = cos\,x/(u - lnt)$
3. $f(x,u) = \frac{u^3}{x^2 + 1}$	6. $f(x,y,z) = \sqrt{x^2 - 3y^3 + 5z^5}$

INTEGRALS CALCULUS
PROBLEMS

I. **Find the integrals by a direct integration**

1. $\int \frac{dx}{x^3}$	6. $\int \frac{x^2 + \sqrt{x^3} + 3}{\sqrt{x}}\,dx$
2. $\int \frac{dx}{\sqrt{x^3}}$	7. $\int 7^x\,dx$
3. $\int 3^t\,dt$	8. $\int \left(\frac{2 + x}{x}\right)^2 dx$
4. $\int \sqrt{y}\,dy$	9. $\int \frac{(x+1)^2}{\sqrt{x}}\,dx$
5. $\int \left(\frac{1}{Cos^2 x} + \frac{1}{Sin^2 x}\right) dx$	10. $\int \frac{4 - x}{2 + \sqrt{x}}\,dx$

II. Find integrals by the method of variable substitution

1. $\int Cos\,3x\,dx$	6. $\int e^{x^2}\;x\,dx$
2. $\int\left(Sin\frac{x}{2}\;\;+Cos\,3x\right)dx$	7. $\int e^{-\frac{1}{x}}\;\frac{dx}{x^2}$
3. $\int\left(e^x+e^{-x}\right)\,dx$	8. $\int e^{\cos x}\,Sin\,x\,dx$
4. $\int\frac{a}{2}\left(e^{\frac{x}{a}}\;\;+e^{-\frac{x}{a}}\right)dx$	9. $\int\frac{Cos\,x}{1+2Sin\,x}dx$
5. $\int\frac{x\,dx}{x^2+3}$	10. $\int\frac{dx}{x\ln x^2}$

III. Calculate the integrals

1. $\int_0^1\frac{2\;x\,dx}{(x^2+1)}$	6. $\int_0^{\pi/2} Sin^3 x\;dx$
2. $\int_0^1\frac{e^x}{e^x+1}dx$	7. $\int_1^e\frac{ln\,x\,dx}{x}$
3. $\int_{\sqrt{3}}^{\sqrt{7}}\frac{x^3\,dx}{\sqrt[3]{x^4+1}}$	8. $\int_0^{\frac{\pi}{2}} Sin\,x\,Cos\;\;x\,dx$
4. $\int_1^e\frac{\sqrt{1+ln\,x}}{x}dx$	9. $\int_0^{\frac{\pi}{2}}(Sin\,x^3)\;x^2\;dx$
5. $\int_0^4\frac{x\,dx}{\sqrt{x^2+9}}$	10. $\int_1^e\frac{1+ln\,x^5}{x}\,dx$

DIFFERENTIAL EQUATIONS

PROBLEMS

I. **Find general solutions to differential equations with separable variables**:

1. $y' + 2 = 0$	6. $y' = -5 \sin(5x - 2)$
2. $Sin\ x\ dx = -dy$	7. $(2x + 3)dx - 2ydy = 0$
3. $e^y y` = 1$	8. $(\cos y)\ y' = tg\ x\ Sin\ y$
4. $y' = e^x \cdot ctg\ y$	9. $y' = 5^{x-y}$
5. $3y\,dx = 2\sqrt{x}\,dy$	10. $(x+1)dx - 2xydy = 0$

II. Find partial solutions to differential equations with separable variables satisfying the initial conditions

1. $(1+y^2)\ dx - \sqrt{x} \cdot ydy = 0;\ y=0$ *при* $x=1$
2. $y' + y\ tg\ x = 0;\ y = 2$ *при* $x = 0$
3. $\cos x \sin y\ dy - \cos y \sin x\ dx = 0;\quad y = \pi/4$ *при* $x = \pi/3$
4. $y\ dx + ctg\ x\ dy = 0;\qquad y = 1$ *при* $x = \pi/3$
5. $y^2 + x^2 y' = 0;\quad y = 1$ *при* $x = -1$

PROBABILITY THEORY

1. Calculate the probability that have the numbers 2 or 5 in a trial of the experiment consisting of tossing up the hexahedral dice.

2. Calculate the probability of failure of the following pairs of the three independent electrical batteries (№№ 1, 2, and 3) operating in an electrical circuit: № 1 and № 3, № 2 and№ 3, № 1 and № 3, if the probabilities of the individual failure of the batteries are p(№ 1) = 0.3, p(№ 2) = 0.2 and p(№ 3) = 0.5.

3. There are 11 balls in a box, 2 of them are green, 3 are black, 5 are red and 1 is a blue ball. What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

4. There are 11 balls in a box, 1 of them is a green ball, 5 are black, 3 of them are red and 2 of them are blue. What is the probability to take (a) a black ball, if you have taken out a green one before it? (b) a red ball, if you have taken out a green one before it? (c) a blue ball, if you have taken out a green one before it?

5. There are 21 balls in a box, 12 of them are green, 3 are black, 5 are red and 1 is a blue ball. What is the probability to take a black ball and a green one in two consequent trials, if the black ball is not put back into the box after the first trial?

THE DISTRIBUTIONS OF RANDOM VARIABLES

6. Find the variance and the standard deviation of a random variable, if the random variable has the following distribution law:

x	0,35	0,55	0,77	0,89
p	0,2	0,3	0,3	0,2

7. Find the variance and the standard deviation of a random variable, if the random variable has the following distribution law:

x	5	7	10
p	0,3	0,4	0,3

STATISTICAL METHODS OF DATA PROCESSING
ERRORS OF MEASUREMENTS

8. Estimate the error of direct measurements:
75, 73, 79, 80, 78, 76, 69, 80, 74, 75, (α=0.95)
2. Estimate the error of direct measurements:
20, 22, 19, 21, 21, 20, 18, 20, 19, 20, (α=0.99)

9. Estimate the error of an indirect measurement: $F = x^2 \cdot y/z$, where ***F*** is the result of indirect measurement and the values ***x, y*** and ***z*** represent the results of three direct measurements:
x: 2.5; 2.6; 2.4; $\Delta x_{inst} = 0.2$
y: 11.9; 12.5; 12.4; 12.4; $\Delta y_{inst} = 0.9$
z: 1.5; 1.7; 1.6; $\Delta z_{inst} = 0.01$
The confidence probability (α) is here 95%.
10. Estimate the error of an indirect measurement: $F = x^2 \cdot y/z^3$, where ***F*** is the result of indirect measurement and the values ***x, y*** and ***z*** represent the results of three direct measurements:
x: 1.4; 1.5; 1.3; $\Delta x_{inst} = 0.1$
y: 20.5; 21.3; 21.2; 21.2; $\Delta y_{inst} = 0.5$
z: 0.5; 0.7; 0.6; $\Delta z_{inst} = 0.01$
The confidence probability (α) is here 95%.

11. Estimate the error of an indirect measurement of the value ***F***, represent the results of the indirect measurement of the value F in the standard form: $F_0 = \bar{F} \pm \Delta F$ where ***F*** is calculated according to the following mathematic formula: $F = x^2 \times y^4 \times z^7$ and the values ***x,y*** and ***z*** represent the results of the direct measurements, ***x***= 2.2, 2.4, 2.3, ***y*** = 11, 14, 12, ***z*** = 0.9, 0.6, 0.7; the errors of the measurement instruments are 0.03, 0.1 and 0.02, respectively. Assume that the confidence probability (α) is 95%.

STATISTICAL HYPOTHESES AND THEIR ESTIMATION

12. Determine the mode, the median, the mean value and the standard deviation of the variation series.

24, 30, 22, 26, 20, 28, 24, 28, 26, 22.

13. Find the mode, the mean value and the standard deviation of a sample, if a sample has the volume n = 70. This sample is drawn from the general population. It is characterized by the following distribution:

x_i	33	26	29	28	31
m_i	19	11	13	17	10

14. Solve the problem of H_0 - hypothesis by using a method of confidence intervals, if the sample X represents the results of measurements of a physical factor in a group of sick patients and Y represents the results of measurements of the physical factor in a group of healthy persons α = 95%:
X: 37, 39, 38, 38, 40, 37, 39.
Y: 40, 47, 48, 41, 41, 45, 40.

15. Solve the problem of H_0 - hypothesis by using the method of **X criterion**; a set of experimental results x_1, represents here the result of measurements of the body mass in an experimental group of laboratory animals and x_2 represents the results of measurements of the body mass in a control group of animals $\alpha_1 = 95\%$, $\alpha_2 = 99\%$.
x_1: 6.7, 5.9, 5.9, 6.1, 6.4, 6.2, 6.2, 6.1, 6.3, 6.2
x_2 : 6.4, 6.2, 6.1, 6.3, 6.0, 6.9, 6.0, 6.1, 6.2, 6.0.

16. Solve the problem of H_0 - hypothesis by using the method of **U - criterion**, a set of experimental results x_1 represents the result of measurements of a blood parameter in an experimental group of laboratory animals and x_2, represents here the results of measurements of the blood parameter in a control group of animals, $\alpha = 99\%$.
x_1 :75,70, 64, 68,72, 79, 76, 83, 80;
x_2 :71, 70, 66, 60, 62,69, 73, 69, 60, 80, 78.

CORRELATION AND REGRESSION

17. Solve the problem of correlation between two sets of data by using the **Pearson's coefficient** method; characterize the result qualitatively; check the statistical confidence of a conclusion about correlation ($\alpha = 95\%$). See two paired samples below:
X: 40.00; 37.00; 36.50; 38.00; 38.30; 39.90; 37.10
Y: 0.95; 0.90; 0.86; 0.80; 0.95; 0.97; 0.98.

18. Find the **equation of regression** for two correlated scores and draw a **linear diagram**. See two paired samples below:
X: 120, 125,127, 134, 142, 149, 153, 159, 161, 167;
Y: 90, 120,190, 270, 220, 250, 290, 340, 440, 480.

PHYSICS

MECHANICS OF LIQUIDS AND GASES. ACOUSTICS.

1. Calculate the rate of a fluid flow from a small hole in an open vessel. The height of the liquid column in the vessel is 20 cm; the hole from which the liquid flows is 3 cm from the bottom of the vessel. (Take the rate of lowering of the liquid level in the vessel as zero, and neglect the viscosity).

2. At what height from the bottom is a small hole from which water flows at a velocity of 2 m / s, located in an open vessel, if the height of the water column is 35 cm. (Take the rate of lowering of the water level in the vessel as zero, and neglect the viscosity).

3. Determine the volume of blood flowing through a vessel with a radius of 2 mm in 5 minutes, if the drop in static pressure in this vessel is 10^4 Pa. Take the length of the vessel equal to 3 cm. Consider the vessel walls rigid.

4. Determine the volume of blood flowing through a vessel with a radius of 3 mm in 10 minutes, if the pressure difference in the area of the vessel with a length of 5 cm is 2×10^4 Pa. The vessel walls are considered rigid, the flow is laminar.

5. What additional pressure should be applied to push the air bubble formed in the blood vessel, if one meniscus of the bubble has a radius of curvature equal to 1.5 mm, and the second to 2.5 mm?

6. Determine at what velocity the flow of blood in a vessel with a radius of 1 cm will become turbulent. The critical value of the Reynolds number is 1500.

7. In the aorta of a dog with a diameter of 1.5 cm, determine the average blood flow rate, considering the kinematic viscosity coefficient equal to 5×10^{-6} m^2/s, and the Reynolds number equal to 4500. (The blood flow changes from laminar to turbulent.)

8. What is the mechanical work of the right ventricle of the heart, performed during active muscle activity, if the work of a single contraction of the heart is equal to 2.4 J?

9. What is the mechanical work of a single heart contraction, if the average static pressure in the aorta is 14000 Pa, the shock volume of blood is 6×10^{-5} m^3, and the blood velocity in the aorta is 0.8 m/s?

OPTICS

10. The linear magnification of the microscope is 400, and the size of the object under study is 20 microns. What is equal to: the linear magnification of the lens, the linear dimensions of the image in the lens and in the eyepiece of the microscope, if the magnification of the eyepiece is 100?

11. In a microscope, the focal length of the lens is 4 mm, and the eyepiece is 20 mm. What is the magnification of the microscope, if the optical length of the tube is 17 cm.

12. The linear magnification of the microscope is 500. Determine the optical length of the tube, if the focal length of the lens is 6 mm, and the eyepiece is 18 mm.

13. What is the focal length of the eyepiece, if the magnification of the microscope is 450, the optical length of the tube is 15 cm, and the focal length of the lens is 6 mm?

14. In the microscope, the focal length of the lens is 5 mm, the eyepiece-25 mm. Find the optical length of the tube, if the linear magnification of the lens is 4, and the magnification of the eyepiece is 100.

15. Calculate the critical angle of total internal reflection, if refractive indices of the mediums are 1.36 and 1.59. Draw the diagram of ray-tracing.
16. Find the critical angle of total internal reflection on the interface of two mediums, if refractive indices of the mediums are 1.35 and 1.55. Draw the diagram of ray-tracing.

17. Determine the angle of rotation of the polarization plane, if the mass concentration of sugar c = 20 kg / m^3, the length of the tube l =10 cm. The specific rotation of sugar is taken to be equal to 0.4 deg×m^2/kg.

18. Find the intensity of the light coming out of the analyzer, if the intensity of the light incident on the polarizer I_o = 70 W / m^2, and the angle between the main planes of the polarizer and the analyzer φ= 45°.

ELECTRODYNAMICS. PHYSICAL PROCESSES IN TISSUES WHEN EXPOSED TO CURRENT AND ELECTROMAGNETIC FIELDS. FUNDAMENTALS OF MEDICAL ELECTRONICS.

19.What is the DC power consumed for heating the soft tissue area? The soft tissues has the following dimensions: the cross-sectional area of the circuit is 10 cm^2, a depth is 5 mm, the resistivity of the living tissues is 2 Ohms×m. The current density is 10 mA / mm^2.

20.What is the DC power consumed for heating the soft tissue area? The soft tissues has the following dimensions: the cross-sectional area of the circuit is 10 cm^2, a depth is 5 mm, the resistivity of the living tissues is 2 Ohms×m. The current density is 10 mA / mm^2.

21. Determine the frequency of electromagnetic oscillations and the name of the frequency range, according to the medical classification, if the wavelength in a vacuum is: a) 3m, b) 15 cm, c) 3 mm.

22. Determine the impedance and phase shift between the sinusoidal current and the voltage in the gum tissues, if the capacitance of the circuit section through which the current flows is 6×10^{-9} Farad, the electrical resistance is 30 kOhms, and the linear frequency is 2000 Hz. Consider the resistance and capacitance connected in parallel.

23. What is the amount of heat released in bone tissue during UHF therapy, if the relative permittivity of the tissue is 50, the angle of dielectric loss is 15°, the amplitude of the electric component of the electromagnetic field is 2500 V/m? (For calculations, use a frequency equal to 40.5 MHz).

24. Draw an Einthoven triangle and an electrocardiogram of any two leads. According to Einthoven's theory, they are projections in the ECG. Restore the shape of the vector electrocardiogram. The electrical axis of the heart is considered to be located at an angle of 30°.

IONIZING RADIATION, BASICS OF DOSIMETRY.

25. Radon activity in a closed vessel is 650 mCi. What time will the radon activity in the vessel be equal to 5×10^{8} Bc? Take the decay constant equal to 2×10^{-2} day^{-1}. (Perform calculations by counting the time in days).

26. Radon activity in a closed vessel is 470 mCi. What time will the radon activity in the vessel be equal to 23×10^{8} Bk? Take the decay constant equal to 4×10^{-2} day^{-1}. (Perform calculations by counting the time in days).

27. What are the absorbed and equivalent doses, the power of these doses, as well as the power of the exposure dose in human soft tissues, if the exposure dose of X-radiation is 4×10^{-8} Cl/kg? The exposure time is 3 hours. Take the transition coefficient equal to 0.9.

28. The exposure dose is 3×10^{-13} Cl/kg. Determine the equivalent dose for human bone tissues absorbing α - particles. The transition factor is 3.

29. The exposure dose is 4×10^{-14} Cl/kg. Determine the equivalent dose for human soft tissues absorbing α - particles. The transition factor is 1.

30. Determine the efficiency of the X-ray tube, if the voltage between the anode and the cathode is 60 kV, the anode mirror is made of tungsten. The proportionality coefficient is considered equal to 1.5×10^{-5} %.

5. The content of the assessment tools of mid-term assessment

Mid-term assessment is carried out in the form of a credit.

5.1 The list of control tasks and other materials necessary for the assessment of knowledge, skills and work experience.

5.1.1. Questions for the discipline exam
FSES are not provided

5.1.2. Questions for the credit in the discipline “Physics, mathematics”
https://sdo.pimunn.net/mod/resource/view.php?id=205159 – MATHEMATICS
https://sdo.pimunn.net/mod/resource/view.php?id=205162 – PHYSICS

Question	Competence code (according to the WPD)
MATHEMATICS	
1. THE DERIVATIVE OF A CONSTANT VALUE IS… 1) *0* 2) – 1 3) + 1 4) ∞	UC-1
2. FIND THE DERIVATIVE OF THE FUNCTION $y = ln3x$ 1) $y' = 1/x$ 2) $y' = 1/(3x)$ 3) $y' = x/ln\ 3$	UC-1

4) $y' = 3/ \ln x$	
3. CHOOSE THE TOTAL DIFFERENTIAL df OF THE FUNCTION $f(x,y) = Sin\, x + Cos\, y$ 1) $df = Cos\, x\, dx - Sin\, y\, dy$ 2) $df = Cos\, x\, dx + Sin\, y\, dy$ 3) $df = Cos\, y\, dx - Sin\, x\, dy$ 4) $df = Cos\, y\, dx + Sin\, x\, dy$	UC-1
4. FIND THE INTEGRAL $\int x^3\, dx$ 1) $3x^2 + C$ 2) $\frac{x^4}{4} + C$ 3) $-\frac{x^4}{4} + C$ 4) $\frac{1}{4x^4} + C$	UC-1
5. CALCULATE THE DEFINITE INTEGRAL $\int_3^{24} dx$ 1) 0 2) 1 3) 8 4) 21	UC-1
6. CHOOSE THE GENERAL SOLUTION OF THE DIFFERENTIAL EQUATION $y' Cos\, y = Sin\, x$ 1) $Sin\, y = -Cos\, x + C$ 2) $Sin\, y = -Cos\, x \cdot C$ 3) $Sin\, y = Cos\, x + C$ 4) $Sin\, y = Cos\, x \cdot C$	UC-1
7. A DISCRETE RANDOM VARIABLE IS REPRESENTED BY THE DISTRIBUTION x: 5, 7; p: 0.4, ? CHOOSE THE MATHEMATICAL EXPECTATION 1) 4.8 2) 2.4 3) 1.6 4) 6.2 5) 7.8	UC-1
8. THE NORMAL LAW GRAPH HAS THE FORM OF THE…. 1) straight line 2) hyperbola 3) bell-shaped curve 4) exponent 5) parabola	UC-1
9. CHOOSE THE ANALYTICAL FORM OF THE POISSON'S LAW	UC-1

1) $p_n(m) = \frac{\mu^m}{m!} e^{-\mu}$ 2) $p_n(m) = \frac{\mu^m}{m!} e^{\mu}$ 3) $p_n(m) = \frac{\mu^m}{(m-\mu)!} e^{m-\mu}$ 4) $p_n(m) = \frac{n!}{m!(n-m)!} p^m (1-p)^{n-m}$ 5) $p_n(m) = \frac{n!}{m!(n-m)!} p^m (n-p)^{n-m}$	
10. CHOOSE THE MINIMUM VOLUME OF A REPRESENTATIVE SAMPLE 1) 10 2) 8 3) 5 4) 3 5) 1	UC-1
11. THE H_0 HYPOTHESIS CAN BE REJECTED IN THE STUDENT'S CRITERION, IF… 1) $t_{exp} \geq t_{crit}$ 2) $t_{exp} < t_{crit}$ 3) $t_{a\ priori} > t_{crit}$ 4) $t_{a\ priori} < t_{a\ posteriori}$ 5) $t_{a\ posteriori} > t_{crit}$	UC-1
PHYSICS	
1. SPECIFY THE PLANCK'S CONSTANT IN THE EQUATION FOR QUANTUM ENERGY $E = hc/\lambda$ 1) E 2) h 3) c 4) λ	UC-1
2. INTERNAL FRICTION FORCES ARE DIRECTED 1) at an angle of 90° to the surfaces of contacting layers 2) along the surfaces of contacting layers 3) at an angle of 30° to the surfaces of contacting layers 4) at an angle of 45° to the surfaces of contacting layers	UC-1
3. WITH AN INCREASE IN TEMPERATURE, A RATE OF THE THERMAL MOTION OF MOLECULES 1) decreases 2) increases 3) does not change 4) varies with viscosity	UC-1
4. AT NORMAL LIGHT INCIDENCE, THE MAIN DIFFRACTION MAXIMUMS ARISE UNDER THE FOLLOWING CONDITIONS: 1) $d\,Sin\alpha = \pm k\lambda$ 2) $d/Sin\alpha = \pm k\lambda$ 3) $d/Sin\alpha = \pm k/\lambda$ 4) $d + Sin\alpha = \pm(k+\lambda)$	UC-1

5) $d\,Sin\alpha = \pm k/\lambda$	
5. IT IS KNOWN THAT BLOOD IS A NON-NEWTONIAN LIQUID. THIS IS EXPLAINED BY THE FACT THAT 1) blood cells vary in shape and size 2) blood cells move chaotically 3) blood plasma has high viscosity 4) blood corpuscles form aggregations	UC-1
6. ABSORPTION OF X-RAY RADIATION IN A LAYER OF A SUBSTANCE IS HIGHER IN CASE OF… 1) harder beams (having shorter wavelengths) 2) softer rays (having longer waves) 3) more contrasting rays 4) more coherent beams	UC-1

Theoretical Questions for the test	
Question	Competence code (according to the WPD)
MATHEMATICS	
1. A random event. Probability determination (statistical and classical). The concept of joint and incompatible, dependent and independent, equally and unequally probable events. Examples.	UC-1
2. Theorems of addition and multiplication of probabilities. Conditional probabilities.	UC-1
3. Total probability. Bayes' theorem.	UC-1
4. Discrete and continuous random variables. Numerical characteristics of continuous and discrete random variables (mathematical expectation, variance, mean square deviation).	UC-1
5. The normal distribution law of continuous random variables. Analytical and graphical types of the normal law. Examples of random variables described by a normal law. Probability density. Standard intervals. Mathematical expectation and variance, for the corresponding quantities. Examples.	UC-1
6. Properties of binomial distribution, Bernoulli formula. Distribution parameters. Examples.	UC-1
7. Poisson distribution, its properties. Distribution parameters. Examples.	UC-1
8. The confidence interval and confidence probability. Student's coefficient. Calculation of the confidence interval. The probability of a random variable falling into the confidence interval. Standard intervals.	UC-1
9. Variation series. Ranking. Methods of plotting variation series: histograms, frequency polygons, cumulates.	UC-1
10. The parent population and sample. Sample volume, representativeness. Estimation of the parameters of the general population according to the characteristics of the sample	UC-1
11. Direct and indirect measurements (definitions, examples). Types of measurement errors. Absolute and relative measurement errors. Examples.	UC-1
12. Statistical hypotheses and their verification. The concept of the null	UC-1

hypothesis. Parametric Student's criterion (Student's t - criterion), its properties. Conditions of its application.	
13. The problem of Statistical hypotheses testing. The “interval method”. Parametric and non-parametric methods. The concept of the null hypothesis. Metods based on rank order: the Van der Varden X-test; the Mann -Whitney U test; the Z sign criterion.	UC-1
14. Correlation, correlation and functional relationships. Differences between correlation and functional. Correlation coefficient – the Pirson’s coefficient of correlation.	UC-1
15. Correlation, correlation and functional relationships. Differences between correlation and functional. The Fechner correlation coefficient.	UC-1
16. Regression analysis. Regression lines. Linear regression equations, regression coefficients. The linear correlation coefficient, its properties.	UC-1
PHYSICS	
1. Sound. Types of sounds (definitions). Wave resistance. Acoustic spectrum, types of spectra (draw).	UC-1
2. Objective (physical) characteristics of sound: energy flow, energy flow density (intensity). Definitions, units of measurement.	UC-1
3. Subjective characteristics of sound. The connection between them is objective.	UC-1
4. Ultrasound. Physical features of ultrasound, principles of operation of ultrasonic emitters (draw a block diagram). The principle of obtaining ultrasound.	UC-1
5. Ideal fluid. The laws of the flow of an ideal fluid (continuity, Bernoulli, Torricelli).	UC-1
6. Concepts of stationary flow. Laminar and turbulent flows. Current surface lines (layers). Reynolds number (explain, write formulas). The critical value of the Reynolds number. Kinematic viscosity coefficient.	UC-1
7. Viscosity of the liquid. Newton's equation. Viscosity coefficient (definition, units of measurement). Newtonian and non-Newtonian fluids, examples.	UC-1
8. Explain in detail the course of the experiment to determine the viscosity coefficient of liquids by the Ostwald method, give a formula for calculating the viscosity coefficient in this experiment.	UC-1
9. Poiseuille formula. Conditions for the applicability of Poiseuille's law. Hydraulic resistance.	UC-1
10. Serial and parallel connection of tubes. Formulas for hydraulic connection of series and parallel connected tubes.	UC-1
11. Geometric optics. The phenomenon of total internal reflection of light. The limiting angle of total reflection and the limiting angle of refraction. The course of the rays (draw). Derivation of formulas for determining the angle of total reflection and the limiting angle of refraction (figures). Fiber optics.	UC-1
12. Refractometry. The scheme of the refractometer. Explain in detail the course of the experiment to determine the refractive index of a transparent liquid with a refractometer (draw).	UC-1
13. Microscopy. The course of rays in an optical microscope. Characteristics of images. Derivation of the linear magnification formula of the microscope.	UC-1
14. Resolution and resolution limit of optical devices (microscope, eyes). The concept of Abbe theory, the main provisions of Abbe theory. The course of rays according to Abbe's theory. Useful magnification of the microscope.	UC-1
15. Polarization of light. Methods of obtaining polarized light. Malus' law. Optical activity.	UC-1
16. Laser. Coherence of radiation. The concepts of inverse population, forced radiation. The working substance of the laser. Types of energy pumping sources. Features of laser radiation.	UC-1

17. X-ray radiation. X-ray tube. Interaction of X-ray radiation with matter, physical bases of application in medicine.	UC-1
18. Radioactivity. The law of radioactive decay. Activity. Interaction of ionizing radiation with matter. Ionizing radiation detectors.	UC-1
19. Dosimetry of ionizing radiation. Types of dosimeters, technical principles of their operation. Absorbed, exposure and equivalent doses. Dose rate. Radiation background.	UC-1

5.1.3. The subject of term papers *(if provided by the curriculum)*
FSES are not provided

6. Criteria for evaluating learning outcomes

For the credit

Learning outcomes	Evaluation criteria	
	Not passed	**Passed**
Completeness of knowledge	The level of knowledge is below the minimum requirements. There were bad mistakes.	The level of knowledge in the volume corresponding to the training program. Minor mistakes may be made
Availability of skills	Basic skills are not demonstrated when solving standard tasks. There were bad mistakes.	Basic skills are demonstrated. Typical tasks have been solved, all tasks have been completed. Minor mistakes may be made.
Availability of skills (possession of experience)	Basic skills are not demonstrated when solving standard tasks. There were bad mistakes.	Basic skills in solving standard tasks are demonstrated. Minor mistakes may be made.
Motivation (personal attitude)	Educational activity and motivation are poorly expressed, there is no willingness to solve the tasks qualitatively	Educational activity and motivation are manifested, readiness to perform assigned tasks is demonstrated.
Characteristics of competence formation*	The competence is not fully formed. The available knowledge and skills are not enough to solve practical (professional) tasks. Repeated training is required	The competence developed meets the requirements. The available knowledge, skills and motivation are generally sufficient to solve practical (professional) tasks.
The level of competence formation*	Low	Medium/High

For testing:

Mark "5" (Excellent) - points (100-90%)
Mark"4" (Good) - points (89-80%)
Mark "3" (Satisfactory) - points (79-70%)

Less than 70% – Unsatisfactory – Mark "2"

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