Syllabus educational component

Discipline name:	Metrology, technological measurements and instruments
Level of higher education:	First (bachelor's)
Course page in Moodle:	https://dl2022.khadi- kh.com/course/index.php?categoryid=740
The volume of the	3 credits (90 hours)
educational component	
Form of final control	Passed
Consultations:	on schedule
Name of the department:	Department of Metrology and Life Safety
Language of instruction:	English
Course leader:	Olga Maletska, Ph.D.
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Metrology, technological measurements and instruments

Summary of the educational component:

The aim is to train specialists in metrology and metrological activity on the basis of studying the basics of legislative, theoretical and applied metrology.

Subject: Requirements of legislative metrology, measuring instruments, measuring systems, determination and verification of metrological characteristics, requirements for measurements, measurement methods, errors and uncertainty of measurements, measurement of pressure, temperature, flow rate.

The main tasks of studying the discipline are:

 formation of the conceptual apparatus for the provision of services in the field of metrology and metrological activity on the basis of knowledge of legal requirements, the acquisition of knowledge on the handling of measuring instruments;

 acquisition of the necessary skills of applying the acquired knowledge to solve practical problems in the field of metrology and metrological activity.

Prerequisites for studying the educational component:

Mathematics, Electrical Engineering and Electromechanics, Technical means of automation, Digital measuring instruments.

Competences that the applicant acquires:

General competencies:

Ability to search, process and analyze information from various sources.

Ability to abstract thinking, analysis and synthesis.

Ability to identify, set and solve problems in the field of metrology and automation.

Ability to adapt and act in a new situation with respect to metrological requirements.

Special (professional) competencies:

The ability to apply during metrological activities:

- requirements of legislative metrology for measuring instruments and measurements;

- methods for determining the components of errors and uncertainty of measurements;

- knowledge of types and methods of verification and calibration of measuring instruments;

- methods for selecting categories and/or types of measuring instruments, depending on the measurement task.

Ability to use the principles, methods and organizational procedures of metrology and metrological activity.

Ability to apply and integrate knowledge and understanding of disciplines of related engineering fields.

Learning outcomes:

Possess modern methods of scientific knowledge at the level of the latest achievements in the field of metrology, necessary for research and / or innovation, to carry out information search and analyze its results.

Possess methods for assessing the error and uncertainty of measurements, their processing and analysis, methods for selecting measuring instruments and forming measuring channels of automated systems for solving specific measuring problems.

Demonstrate and implement in professional activities knowledge of the principles and methods of metrological activity.

		Number of	
No		hours	
tormi	Title of topics (LK, LR, PR, SZ, WED)		Corres
(CIIII		Eye	ponden
№ temi			се
	LUKE. Law of Ukraine "On Metrology and Metrological Activity".		
	Fundamentals of ensuring the unity of measurements in Ukraine.		
1	History of Metrology. Types of metrology. Unity of measurements.	2	
	Introduction of European requirements in the field of metrology.		
	The scope of legally regulated metrology.		
	PR1. Comparison of metrological activity in different countries.	2	
	PR2. Determination of the sphere of legally regulated metrology	2	
	in measurements at the enterprise.	2	
	WED. Study of the material of the topic LC 1. Registration of the		
	report on PR 1 and PR 2. Preparation for the implementation of	З	
	PR 1 and 2. Study of the Law of Ukraine "On Metrology and	0	
	Metrological Activity".		
	LUKE. Units of measurement and their application.	0	
	International value system. International system of units. Units	2	
2	PR3 The use of units of measurement	2	
	WED. The study of the material of the tonia LC 2. Branaration for	2	
	the implementation of DP 2. Periotration of the report on DP 2	3	
	the implementation of PK 3. Registration of the report of PK 3.		

Thematic plan

	LUKE. Measuring instruments. Classification.		
	Definition of concepts relating to measuring instruments. Classification of measuring instruments according to them: scope, measurement operations, principle of operation.	2	
3	PR 4. Determination of requirements for the use of measuring instruments in the enterprise.	2	
	WED. Study of the material of the topic LC 3. Preparation for the implementation of PR 4. Registration of the report on PR 4.	3	
	LUKE. Metrological characteristics of measuring instruments.		
	Categories and types. Maximum permissible errors. Accuracy classes. Errors depending on the climatic, mechanical and electromagnetic conditions of application.	2	
4	PR 5. Determination of the main metrological characteristics of measuring instruments and accuracy classes.	2	
	PR 6. Determination of additional metrological characteristics of measuring instruments	2	
	WED. The study of the material of the topic LC 4. Preparation for the implementation of PR 5 and PR 6. Registration of the report on PR 5 and PR 6.	4	
5	LUKE. Requirements for measurements. The concept of measurements. Types of measurements. Application in the enterprise. Methods and methods of measurement.	2	
	PR 7. Establishing requirements for measuring quantities.	2	
	WED. The study of the material of the topic LC 5. Preparation for the implementation of PR 7. Registration of the report on PR 7.	3	
	LUKE. Measurement errors. Estimating errors Measurement accuracy. Types of errors. Methods for estimating random and systematic errors.	2	
C	PR 8. Establishing requirements for measurement errors.	2	
0	PR 9. Evaluation of measurement errors	2	
	WED. The study of the material of the topic LC 6. Preparation for the implementation of PR 8 and PR 9. Registration of the report on PR 8 and PR 9.	3	
	LUKE. Correctness and precision of measurements. Methods for assessing correctness, precision. Repeatability and reproducibility. Application to assess the reliability of measurement results.	2	
7	PR 10. Evaluation of the correctness of measurements.	2	
	PR 11. Evaluation of the precision of measurements.	2	
	WED. The study of the material of the topic LC 7. Preparation for the implementation of PR 10 and PR 11. Registration of the report on PR 10 and PR 11.	3	

	LUKE. Measurement of temperature, pressure and flow rate.		
	Means of measuring temperature, pressure and flow rate.	2	
	Sensors for measuring channels of automated systems. Selection	2	
8	of sensors and measuring transducers.		
	PR 12. Temperature measurement.	2	
	PR 13. Pressure measurement.	2	
	PR 14. Flow measurement.	2	
	PR 15. Determination of the error of the measuring channel.	2	
	PR 16. Determination of the error of the software and hardware	2	
	complex.	2	
	WED. The study of the material of the topic LC 8. Preparation for		
	the implementation of PR 12-16. Registration of the report on PR	15	
	12-16. Preparation of answers to questions for the test.		
Togo	LUX	16	
thor	AVE	32	
uiei	WED	37	

Individual educational and research task (if any): not provided.

Teaching methods:

verbal (lectures, explanations, narration, conversation, discussion, work with a book, etc.) visual (method of illustration and demonstration), practical tasks.

Grading system and requirements: Current success:

1 The current success of applicants for the performance of educational types of work in training sessions and for the performance of tasks of independent work is assessed using a four-point scale of grades, followed by recalculation into a 100-point scale. During the assessment of current performance, all types of work provided for by the curriculum are taken into account.

1.1 Lectures are evaluated by determining the quality of performance of specific tasks.

1.2 Practical classes are assessed by the quality of the control or individual task, the performance and design of practical work.

1.3 Laboratory classes are assessed by the quality of the implementation of reports on the performance of laboratory work.

1.4 Seminars are evaluated by the quality of the individual task/abstract.

2 Evaluation of the current performance of applicants for higher education is carried out at each practical lesson (laboratory or seminar) on a four-point scale ("5", "4", "C", "2") and are recorded in the journal of accounting for academic performance.— " excellent": the applicant perfectly mastered the theoretical material, demonstrates deep knowledge of relevant topic or academic discipline, main provisions;

- "good": the applicant has mastered the theoretical material well, owns the main aspects from primary sources and recommended literature, reasonably teaches it; has practical skills, expresses his reasoning about certain problems, but assumes certain inaccuracies and errors in the logic of presenting theoretical content or in the analysis of practical;

- "satisfactory": the applicant has mainly mastered the theoretical knowledge of the educational topic, or discipline, is guided in primary sources and recommended literature, but unconvincingly answers, confuses concepts, uncertainly answers additional

questions, does not have stable knowledge; answering questions of a practical nature, reveals inaccuracies in knowledge, does not know how to evaluate facts and phenomena, connect them with a future profession;

– "unsatisfactory": the applicant has not mastered the educational material of the topic (discipline), does not know scientific facts, definitions, is almost not oriented in primary sources and recommended literature, there is no scientific thinking, practical skills are not formed.

3 The final score for current activities is recognized as the arithmetic average sum of points for each lesson, for individual work, current tests according to the formula:

$$K^{nomov} = \frac{K1 + K2 + \ldots + Kn}{n},$$

where K^{nomov} is the final assessment of success based on the results of current control;

 $K1, K2, \dots, Kn$ – assessment of the success of the -th measure of current control; n

n – the number of measures of current control.

Scores are converted to points according to the recalculation scale (Table 1).

 Table 1 – Recalculation of the average score for current activities into a multi-point scale

4-point scale	100- point scale	4- point scale	100- point scale	4- point scale	100- point scale	4- point scale	100- point scale
5	100	4,45	89	3,90	78	3,35	67
4,95	99	4,4	88	3,85	77	3,3	66
4,9	98	4,35	87	3,80	76	3,25	65
4,85	97	4,3	86	3,75	75	3,2	64
4,8	96	4,25	85	3,7	74	3,15	63
4,75	95	4,20	84	3,65	73	3,1	62
4,7	94	4,15	83	3,60	72	3,05	61
4,65	93	4,10	82	3,55	71	3	60
4,6	92	4,05	81	3,5	70	from 1,78 to 2,99	from 35 to 59
						Reassemb	ly
4,55	91	4,00	80	3,45	69	from 0 to 1,77	from 0 to 34

4,5	90	3,95	79	3,4	68	Re-study

Final assessment

1 The applicant for higher education receives credit at the last lesson in the discipline based on the results of the current assessment. The average score for current activities is converted into points on a 100-point scale, according to the recalculation table (Table 1).

Applicants for higher education who have an average current grade in a discipline lower than "3" (60 points) in the last lesson can increase their current score by passing tests in the discipline.

Assessment of knowledge of applicants by testing is carried out on a scale:

- "Excellent": at least 90% of correct answers;

- "Very good": from 82% to 89% of correct answers;

- "Good": from 74% to 81% of correct answers;

- "Satisfactory": from 67% to 73% of correct answers;

- " Satisfactory enough": from 60% to 66% of correct answers;

- " Unsatisfactory": less than 60% of correct answers.

2 The condition for obtaining the test is:

- working out all missed classes;

- the average current score in the discipline is not lower than "3" (60 points).

3 For the implementation of individual independent work and participation in scientific events, applicants are awarded additional points.

3.1 Additional points are added to the sum of points scored by the higher education student for current academic activities (for disciplines for which the test is the final form of control), or to the final grade in the discipline for which the exam is the final form of control.

3.2 The number of additional points awarded for different types of individual tasks depends on their volume and significance:

 prizes in the discipline at the international / all-Ukrainian competition of scientific student works – 20 points;

- prizes in the discipline at the All-Ukrainian Olympiads - 20 points;

 participation in the international / all-Ukrainian competition of scientific student works – 15 points

 participation in international / all-Ukrainian scientific conferences of students and young scientists – 12 points;

- participation in all-Ukrainian olympiads in the discipline - 10 points

participation in olympiads and scientific conferences of KhNADU in the discipline
 5 points;

- implementation of individual research (educational and research) tasks of increased complexity - 5 points.

3.3 The number of additional points may not exceed 20 points.

4 The result of training is evaluated *(choose the right one)*:

- on a two-point scale (credited/not credited) according to table 2;

- on a 100-point scale (for differentiated standings) according to Table 3.

The final score, together with additional points, cannot exceed 100 points.

On a 100-point scale	On a national scale						
from 60 points to 100 points	enrolled						
less than 60 points	unzarached						

\mathbf{I} able \mathbf{Z} - Scale of transfer of points to the national urading system	Table 2 – Scale	of transfer of	points to the	national d	rading system
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 Table 3 – Scale of assessment of applicants' knowledge based on the results of the final control in the discipline

	National	مادعه		ECTS score			
Score in	SCO	re					
noints	500		Score	Criteria			
points	Exam	Passe	00010	Ontena			
				The theoretical content of the course is mastered			
	<u>></u>	g		entirely, without gaps, the necessary practical			
00 100	ect	lle	•	formed all the training tooks provided by the			
90-100	erfe	uro	A	training program have been completed the			
	Å	Ξ		quality of their implementation is estimated by the			
				number of points close to the maximum			
				The theoretical content of the course is mastered			
				entirely without gaps, the necessary practical			
				skills in working with the mastered material are			
80–89			В	mainly formed, all the training tasks provided by			
				the training program have been completed, the			
				quality of most of them is estimated by the			
	_			number of points close to the maximum			
	Vel	We	With	The theoretical content of the course is mastered			
	-			entirely, without gaps, some practical skills of			
				working with the mastered material are not			
75-79				sufficiently formed, all the training tasks provided			
				by the training program have been completed,			
		ed		the quality of none of them is assessed by the			
		llo		minimum number of points, some types of tasks			
		Enr		The theoretical content of the source is perticily			
		-		mastered but the gaps are not significant, the			
				necessary practical skills in working with the			
67-74			П	mastered material are mainly formed most of the			
0114	Ż			training tasks provided by the training program			
	tor			have been completed, some of the tasks			
	fac			performed may contain errors			
	Itis			The theoretical content of the course is partially			
	Sa			mastered, some practical skills of work are not			
60-66			Δnd	formed, many of the training tasks provided by			
00-00				the training program have not been completed, or			
				the quality of some of them is estimated by the			
				number of points close to the minimum.			

National scale		ECTS score				
Score in	score		0			
points	Exam	Passe d	Score	Criteria		
35–59	Disappointing	Disappointing ot credited X4		The theoretical content of the course is partially mastered, the necessary practical skills of work are not formed, most of the provided training programs have not been completed, or the quality of their implementation is estimated by the number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of the training tasks (with the possibility of re- compilation)		
0–34	Unacceptable	NG	F	The theoretical content of the course has not been mastered, the necessary practical skills of work are not formed, all completed training tasks contain gross errors, additional independent work on the course material will not lead to any significant improvement in the quality of the training tasks (with a mandatory repeated course)		

Course Policy:

- the course involves teamwork, the environment in the audience is friendly, creative, open to constructive criticism;

 mastering the discipline involves the obligatory attendance of lectures and practical classes, as well as independent work;

independent work involves the study of individual topics of the discipline, which are made in accordance with the program for independent study, or were considered briefly;
 all tasks envisaged by the program must be completed within the prescribed period;

- if the applicant for higher education is absent from the classroom for a good reason, he presents the completed tasks during the independent preparation and consultation of the teacher;

- course work must be protected no later than a week before the start of the examination session *(indicated if available)*;

- while studying the course, applicants for higher education must comply with the rules of academic integrity set forth in the following documents: "Rules of academic integrity of KhNADU" participants in the educational process of (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_dobroch_ 1.pdf), "Academic integrity. Verification of the text of academic, scientific and qualification works for plagiarism" (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_85_1_01.pdf), "Moral and ethical code of participants in the educational process of KhNADU (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_MEK_1.p <u>df</u>).

 in case of detection of the fact of plagiarism, the applicant receives 0 points for the task and must re-complete the tasks provided for in the syllabus;

write-offs during tests and exams are prohibited (including using mobile devices).
 Mobile devices are only allowed to be used during online testing.

Recommended literature:

1. Maletska O. "Metrology, technological measurements and devices": lecture notes. Kharkiv KhNADU, 2023. 75 p.

2. R. M. Trisch Metrology and Standardization: Textbook. posib. for stud.Higher. educational institutions / D. A. Yanushkevich, M. V. Moskalenko, O. E. Maletska. Ukr.inzh.- ped.acad. - H.: 2014.- 444 p.

3. DSTU 2681-94. Metrology. Terms and definitions/ https://www.google.com/search?q=3.+%D0%94%D0%A1%D0%A2%D0%A3+2681-94&rlz.

Additional Sources:

1. Law of Ukraine "On Metrology and Metrological Activity": https://zakon. rada. gov/ua.

2. Distance course:

https://dl2022.khadi-kh.com/course/index.php?categoryid=740

Developer (developers) syllabus of the discipline	Jung	Olga MALETSKA	
	signature		
Head of the Department	Signature	Oleg BOGATOV	