Ministry of Science and Higher Education of the Russian Federation
Federal State Autonomous Educational Institution of Higher Education
Perm National Research Polytechnic University

APPROVED BY
Pro-rector for Academic Affairs
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ACADEMIC COURSE WORKING PROGRAM

Academic course: Metrology, Standardization and Certification
(Name)

Form of education: Full-time
(full-time / part-time / correspondence)

Level of higher education: Bachelor's program
(Bachelor's program / Specialist program / Master's program)

Workload in hours (in credits): 108 (3)
(Hours (CU))

Training program (degree): 15.03.06 Mechatronics and Robotics
(Code and denomination of degree)

Direction: Mechatronics and Robotics
(Title of curriculum)

Perm 2021

1 General Provisions

1.1 Goals and Objectives of the Course

The goal of the course is to develop knowledge, abilities and skills in the field of measurement, application of measuring instruments and processing of measurement results.

1.2 Prescribed Objects of the Course

- classification of measurements and errors;
- methods for reducing the errors influence;
- types of measuring instruments and their metrological characteristics;
- instruments for measuring electrical quantities;
- measuring transducers of non-electric quantities;
- forms and methods of standardization and certification.

1.3 Starting Conditions

Unstipulated

2 Planned Results of the Course Training

Competence	Indicator's Index	Planned Results of the Course Training (to know, to be able to, to master)	Indicator of Attaining Competence which the planned results of training are correlated with	Means of Assessment
GPC-12	**IA-1$_{GPC-12}$**	**To know** how to operate, to structure and to use an electrical meter and measuring transducer.	**Knows** technologies of manufacturing application of prototype models of devices and systems.	Test
GPC-12	**IA-2$_{GPC-12}$**	**To be able to** choose and use tools for measuring physical quantities and parameters of signals according to the measuring task.	**Is able to** perform basic acts aimed at putting into operation prototype models of mechatronic and robotic systems, their subsystems and definite modules.	Internship report
GPC-12	**IA-3$_{GPC-12}$**	**To master the skills** of using various physical measuring instruments in practice.	**Has mastered the skills** of organizing assemblage, debugging, adjustment and putting into operation prototype models of mechatronic and robotic systems.	Laboratory work presentation
RPC-1	**IA-1$_{RPC-1}$**	**To know** the fundamentals of metrology and error theory, the origin of errors and methods of their reduction, methods of measurement results processing, objectives and methods of	**Knows** methodology of scientific research, methods of mathematical models of mechatronics' and robotics' processes and objects.	Test

		standardization and certification.		
RPC-1	**IA-2$_{RPC-1}$**	**To be able to** identify and remove systematic measurement errors, use measurement data processing methods to reduce the influence of random errors.	**Is able to** summarize, analyze and systematize information for the preparation of analytical reviews on a given topic, use standard software tools for mathematical modeling of processes and objects of mechatronics and robotics.	Internship report
RPC-1	**IA-3$_{RPC-1}$**	**To master the skills** of using methods to identify errors of direct, indirect and joint measurements.	**Has mastered the skills** of independent study, critical reflection and systematization of scientific and technical information, conducting theoretical research and computational experiments in accordance with the use of selected standard software tools.	Laboratory work presentation

3 Full time and forms of academic work

Form of academic work	**Hours in all**	**Distribution in hours according to semesters**
		Number of semester
		6
1 Holding classes (including results monitoring) in the form: 1.1 Contact classwork, including:	54	54
- lectures (L)	18	18
- laboratory work (LW)	16	16
- practice, seminars and/or other seminar-type work (PW)	18	18
- control of self-work (CSW)	2	2
- test		
1.2 Students' self-work (SSW)	54	54
2 Intermediate attestation		
Exam		
Grading test		
Test (Credit)	9	9
Course Project (CP)		
Course Work (CW)		
Workload in hours	**108**	**108**

4 Course contents

Name of the units with the course outline	Full time of classroom activity in hours according to the forms			Full time of extracurricular work in hours according to the forms
	L	LW	PW	SSW
6th semester				
Fundamentals of metrology	6	0	10	16
Introduction. Objectives of metrology. Basic concepts. Types and measurement methods. Means of measurement. Classification of errors. Characteristics of systematic and random measurement errors. Processing of measurement results.				
Measurement of electrical quantities	6	12	4	18
Electrical parameters. Voltage and current measurement tools. Digital voltmeters. Oscilloscope for electronic beam. Frequency and time interval measurement. Phase shift measurement. Spectral analysis of signals. Electric circuits measurement. Signal parameters measurement in communication systems. Communication line parameters measurement.				
Measurement of non-electrical quantities	4	4	2	16
Parametric transducers. Generator, frequency and digital sensors. Temperature measurement. Measurement of pressure and geometric dimensions. Automation of measurements.				
Fundamentals of standardization and certification	2	0	2	4
Standardization. Basic systems of standards. Product certification.				
Total with regard to 6th semester	**18**	**16**	**18**	**54**
Total with regard to the course	**18**	**16**	**18**	**54**

Topics of exemplary practical works

№	Topic of practical works
1	Definition of systematic measurement errors and correction
2	Dimension accuracy classes
3	Direct single observation measurements
4	Multiple observation measurement results processing
5	Error estimation for indirect measurements
6	Processing of joint measurements results
7	Electrical voltage and current measurement
8	Parameters calculation of transducers
9	Standardization and certification

Topics of exemplary laboratory works

№	Topic of laboratory works
1	Signals analysis with an oscilloscope
2	Frequency and phase shift measurement
3	Circuit parameters measurement (R, L, C)
4	Study of measuring transducers
5	Heterogeneity in communication lines

5 Organizational and Pedagogical Conditions

5.1 Educational Technologies Used for Competences Formation

Holding lectures in the discipline is based on the active method of training in the process of which students are not passive but active participants of the lesson answering questions of the teacher. Teacher's questions are aimed at activating the process of learning material as well as at the development of logical thinking. The questions stimulating associative thinking and connecting new material with the previous one are formulated by the teacher in advance.

Practical lessons are held by realization of the method based on active training: problem areas are determined, groups are formed. The following aims are pursued in the process of practical education: use of definite disciplines knowledge and creative methods in solving problems and decision-making; students' skill-building of teamwork, interpersonal communication and development of leadership skills; consolidation of the basic theoretical knowledge.

Laboratory classes are based on an interactive learning method in which students communicate not only with the teacher but also with each other. At the same time, students' activity in the learning process dominates. The teacher's place in interactive classes is reduced to orienting students' activities to achievement of the goals of studies.

Interactive lectures, group discussions, role-playing games, training sessions, and analysis of situations and simulation models are used in academic studies.

5.2 Students' Manual for the Course Study

Learning the course, it is advisable for students to implement the following recommendations:

1. Learning of the discipline should be done systematically.
2. After learning one of the course units with the help of the text-book or lecture notes it is recommended to reproduce the basic terms, definitions, notions of the unit from memory.
3. Special attention should be paid to the reports on practical studies and individual complex tasks for self-work.
4. The topics list for individual study is given by the teacher at the lectures. The teacher also provides students with literary sources (first of all, new ones in the periodical scientific literature) for a more detailed under-standing of the issues presented at the lectures.

6 List of Teaching Materials and Information Supply for Students' Self work in the Discipline

6.1 Paper-based courseware

№	Bibliographic entry (author, title, mode of publication, place, publishing house, year of publication, number of pages)	Number of copies in the library
1 Basic literature		
1	Raghavendra, Krishnamurthy Engineering Metrology and Measurements. Oxford University Press, Pap/Psc edition, 2013.	
2	Dotson C.L. Fundamentals of Dimensional Metrology. Cengage Learning, 6th edition, 2015.	
2 Additional literature		
2.1 Educational and scientific literature		
1	Griffith G.K. Geometric Dimensioning and Tolerancing: Applications and Inspection. by Pearson, 2001, pp. 350.	
2	Grous A. Applied for Manufacturing Engineering.. Wiley-Iste, 2011, pp. 544.	
2.2 Standardized and Technical literature		
3 Students' manual in mastering discipline		
4 Teaching and learning materials for students' self-work		

6.2 Electronic Courseware

Kind of literature	Name of training tool	Reference to information resource	Accessibility of EBN (Internet / local net; authorized / free access)
Additional literature	Howarth P., Redgrave F. Metrology - in short	http://resource.npl.co.uk/international_office/metrologyinshort.pdf	internet, free access

6.3 License and Free Distributed Software used in the Course Educational Process

Type of Software	Software branding
Operating systems	MS Windows 8.1 (Azure Dev Tools for Teaching)
Office applications	Adobe Acrobat Reader DC
General Purpose Application Software	Dr.Web Enterprise Security Suite

6.4 Modern Professional Databases and Inquiry Systems Used in the Course Educational Process

Branding	Reference to information resource
Scientific Library of Perm National Research Polytechnic University	http://lib.pstu.ru/

Lan' Electronic library system	https://e.lanbook.com/
IPR books Electronic library system	http ://www.iprbookshop.ru/
Information resources of the Network ConsultantPlus	http://www.consultant.ru/
EBSCO database	https://www.ebsco.com/

7 Logistics of the Course Educational Process

Type of classes	Name of the necessary basic equipment	Number of units
Laboratory class	GFG-8217A Generator	12
Laboratory class	Gdm-8245 Multimeter	6
Laboratory class	GOS-620 Oscilloscope	6
Laboratory class	P5-13 Reflectometer	6
Laboratory class	Training Stand "Measurement devices of pressure, flow, and temperature"	1
Laboratory class	Training Kit " Electrical measurement"	1
Laboratory class	Training Stand "Technology Parameter Sensors"	1
Laboratory class	GFC-8010H Digital Frequency Counter	6
Lecture	Projector	1
Practical class	Projector	1

8 Fund of the Course Evaluating Tools

Described in a separate document