Educational institution
"Belarusian State University of Informatics and Radioelectronics"

"Measurements in infocommunications"

EXPLANATORY NOTE

The plan of the academic discipline in the daytime form of study:

Specialty code	Name of specialty	Course	Semester	Classroom hours				Form of current certification
				Total	Lectures	Laboratory works	Practical lessons	
1-45 01 01-02	Infocommunication technologies (infocommunication networks)	3	5	56	32	16	8	Exam
1-45 01 01-05	Infocommunication technologies (multimedia information distribution systems)	3	5	56	32	16	8	Exam

Place of discipline.

The importance of the discipline "Measurements in infocommunications" in the training of engineers in infocommunications is constantly increasing in accordance with the needs of science and technology. The current state of infocommunication and computer and information technology requires new approaches to measurements.

Only engineers with deep professional knowledge in the field of metrological support of infocommunications and trained to work with modern measuring equipment and owning modern measuring technologies can ensure high-quality measurements.

This discipline systematizes and deepens the previously acquired knowledge, skills and abilities, and completes the basic training of infocommunication engineers in the field of metrology and electrical and radio measurements, which must be continuously valid during the entire period of training.

The purpose of the discipline: formation of knowledge in the field of metrology, methods and measuring instruments in infocommunications, skills and abilities of the correct use of measuring instruments in order to obtain reliable measurement results in various areas of future professional activity.

Objectives of the discipline:

– acquisition of knowledge in the field of metrology, methods and measuring instruments in infocommunications;

– formation of skills and abilities of the correct use of measuring instruments in order to obtain reliable measurement results in various areas of future professional activity;

– study of the principles of construction of modern measuring equipment and new measuring technologies in infocommunications;

– mastering the methods of measuring parameters and characteristics of devices, systems and networks of infocommunications.

As a result of studying the discipline "Measurements in Infocommunications", the following competencies are formed:

academic:

1) the ability to work independently and improve your professional level;

2) the ability to apply basic scientific and theoretical knowledge to solve theoretical and practical problems;

3) the ability to organize their work on a scientific basis, independently assess the results of their activities;

4) possession of the basic methods and means of obtaining, storing, processing information;

5) possession of systemic and comparative analysis.

social and personal:

1) ability to work in a team;

2) possession of the ability for social interaction and interpersonal communication.

professional:

1) measure and evaluate the characteristics of infocommunication networks and multimedia information distribution systems;

2) test infocommunication networks and multimedia information distribution systems;

3) study scientific and technical information, domestic and foreign experience on the subject of the project;

4) find failures and malfunctions in infocommunication networks and multimedia information distribution systems;

5) the ability to analyze and evaluate the collected data;

6) the ability to use measuring equipment and measurement methods for monitoring the parameters of the technical operation of infocommunication networks and multimedia information distribution systems.

As a result of studying the academic discipline, the student must:

know:

– basic principles, methods and means of measuring the parameters and characteristics of devices and networks of infocommunications and multimedia information distribution systems;

– specific types of modern electrical and radio measuring instruments and measuring systems of general and special purpose;

– error estimation methods and measurement results processing algorithms;

– main directions of development and improvement of measuring technologies and measuring instruments.

be able to:

– characterize the methods and means of measurement used in infocommunications, methods for processing measurement results;

– analyze the technical and metrological characteristics of measuring instruments when choosing a measurement method and measuring equipment for solving a specific measurement task, the obtained measurement results in terms of ensuring the uniformity of measurements and the quality of services and products;

– methodically correctly perform measurements and draw up measurement results in accordance with applicable standards;

– to control and diagnose the parameters of the equipment of infocommunication networks and multimedia information distribution systems, to establish their compliance with current standards;

– to operate modern electrical and radio measuring equipment in the process of development, production and operation of networks and devices for infocommunications and multimedia information distribution systems.

own:

– standard terminology used in the field of metrology and technical measurements;

– measurement methods and features of their use at all stages of the creation of technical means of infocommunications;

– the legal basis for ensuring the uniformity of measurements.

Content of the discipline

Topics №	Name of sections, topics	Contents of topics
1	2	3
	Section 1. Measurement of the characteristics of signals used in infocommunications	

1	Measurement of current and voltage	Measured parameters of current and voltage. Classification of methods and instruments for measuring current and voltage. Voltage measurement with electronic analog voltmeters. Direct conversion analog voltmeters. The dependence of voltmeter readings on the shape of the curve of the measured voltage. Voltage measurement with electronic digital voltmeters. Digital DC voltmeters with time-pulse and pulse-code analog-to-digital conversion. Digital AC voltmeters. Universal digital voltmeters and multimeters.
2	Electrical power measurement	General information (the concepts of instantaneous, average, impulse, apparent, active and reactive power). Classification of methods and instruments for measuring power. Measurement of the power of low and high frequencies. Measurement of the power of microwave oscillations. Absorbed power measurement. Thermal and electronic methods for measuring absorbed power. Measurement of transmitted power.
3	Measurement of frequency and time intervals	General information and classification of instruments for measuring frequency and time intervals. Digital frequency counters. Typical block diagram, principle of operation, main modes of operation (measurement of frequency, period, frequency ratio, time intervals), measurement errors. Features of measuring low, as well as high and ultra-high frequencies.
4	Phase shift measurement	Classification of methods and instruments for measuring the phase shift. Phase shift measurement by converting it into a time interval. Non-integrating and integrating digital phase meters.
5	Study of the shape of electrical signals and measurement of their parameters	Cathode-beam oscilloscopes and their classifications. Universal cathode-beam oscilloscope. Generalized block diagram of a universal oscilloscope. Characterization of its main functional units. Basic parameters of horizontal and vertical deflection channels. Types of sweeps. Synchronization condition. Types of synchronization. Digital oscilloscopes. Generalized block diagram of a digital oscilloscope. Oscillographic measurements of voltages and time intervals
6	Signal analysis	Signal spectrum analysis. General information and a brief description of the methods of spectrum analysis. Filter and digital spectrum analyzers. Main parameters and scope of spectrum analyzers. Harmonic analyzers (selective voltmeters). Measurement of modulation parameters. The main types of modulation and measured parameters. Measurement of amplitude modulation factor, frequency deviation and frequency modulation index. Measurement of non-linear distortions of signals. Harmonic coefficient as the main quantitative characteristic of non-linear distortions. Spectral and integral methods for measuring the harmonic coefficient of harmonic signals.

7	Measurement of electromagnetic field strength and interference	General information and classification of methods and instruments for measuring the strength of the electromagnetic field and interference. Radio interference and standards for them. The concept of electromagnetic compatibility of radio-electronic means. Basic measurement methods. Field indicators. Field strength meters and measuring receivers. Measurement of psophometric interference voltage. Psophometer. Radio interference meters.
	Section 2. Measurement of parameters and characteristics of networks and systems of infocommunications and their components	
8	Measurement of parameters and characteristics of quadripoles	Levels of signal transmission and their measurements. Level meters. Measurement of attenuation and amplification of quadripoles. Types of attenuation: own, working and introduced. Working attenuation and amplification of quadripoles and their measurement. Basic measurement methods: level differences and comparisons using known oscillator and circuit Z. Insertion loss measurement. Group delay measurement (GD). GD measurement by points (phase characteristic) and by the method of transmission of modulated signals (Nyquist method).
9	Identification of heterogeneities and damages in infocommunication networks	Methods for measuring the distance to damage points on infocommunication lines and their features. Pulse measurement method. Pulse reflectometers with a probing pulse and a single voltage drop. Parameters and characteristics of pulse reflectometers. Methods of measurements using pulsed reflectometers. Identification of inhomogeneities of infocommunication networks based on the obtained reflectograms.
10	Measurement of parameters and characteristics of microwave networks of infocommunications and their components	Characteristics and parameters of microwave devices. Analysis of methods and measuring instruments and their classification. Generalized structural-functional diagram of the measuring device parameters of microwave devices. Types of microwave measuring paths and their components. Panoramic meters of the module of reflection and transmission coefficients. Principle of operation, measurement methods and parameters. Homodyne and heterodyne type S-parameter meters.
11	Measurement of parameters and characteristics of fiber-optic networks of infocommunications and their components	Measured parameters of optical fibers and cables. Classification of methods and instruments for measuring the parameters of optical fibers and cables. Backscatter method. Optical reflectometer with reflected signal shape registration. Measurement of the attenuation of optical cables by the backscattering method. Measurement of dispersion by the backscattering method. Measurement of optical signal levels.

		Optical power meters. Attenuation measurements of optical cables using breakout and insertion loss methods.
12	Monitoring and diagnostics of components of digital networks and infocommunication systems	General characteristics and classification of methods and instruments used in testing components of digital networks and infocommunication systems. Logical analysis. Construction principles, classification, features and applications, parameters of logic analyzers. Types of indication in logic analyzers. Signature analysis. The principle and scheme of generating a signature from a test sequence. Signature analyzers. Features and scope.

List of topics for practical lessons

The purpose of the practical classes is to consolidate the theoretical course, acquire problem-solving skills, and activate students' independent work.

Topics №	The name of the practice session	Content
1	2	3
1	Voltage measurement	Practical development of methods for determining the root mean square, mean rectified and amplitude values of voltage according to the readings of voltmeters. Estimation of errors in the results of voltage measurements. Solution of typical tasks.
6	Signal analysis	Practical mastery of methods for determining the parameters of spectrum analyzers, modulometers, non-linear distortion meters and estimating the error of measurement results obtained using these devices. Solution of typical tasks.
7	Measurement of electromagnetic field strength and interference	Practical development of methods and means for measuring the parameters of the electromagnetic field and methods for estimating the measurement error of these parameters; solving typical tasks.
12	Monitoring and diagnostics of components of digital networks and telecommunications systems	Practical mastering of the features of operation and practical application of logic and signature analyzers. Solution of typical tasks.

List of topics for laboratory classes

The purpose of laboratory classes is to consolidate the theoretical course, acquire the skills of research and independent work, processing experimental data, analyzing results, and preparing reports.

Topics №	The name of the laboratory session	Content
1	2	3
1, 8	Measurement of voltages and signal levels using electronic voltmeters and level meters	Investigation of the dependence of voltmeter readings on the shape of the curve of the measured voltage. Determination of measurement errors of voltage and signal levels.
3	Measurement of frequency and time parameters with a digital frequency meter	Measurement of frequency, period, duration and duty cycle of impulse signals. Definitions of measurement errors for different operating modes of the frequency meter.
5	Study of a universal cathode-beam oscilloscope.	Visual observation and measurement of amplitude and time parameters of electrical signals.
6	Signal Spectrum Analysis	Measurement of the parameters of the spectrum of radio pulse signals. Investigation of the dependences of these parameters on the shape, duration and period of radio signals.
6	Measurement of parameters of modulated signals	Measurement of amplitude modulation coefficient and frequency deviation of AM and FM signals. Estimation of errors in the results of these measurements.
6	Measurement of non-linear distortion of signals	Measurement of non-linear distortions of signals and estimation of errors in the results of these measurements.
9	Investigation of the impulse method for measuring parameters and inhomogeneities in infocommunication lines	Study of the pulse measurement method. Identification of heterogeneities in infocommunication lines
10	Measurement of transmission coefficient modules of microwave devices	Measurement of parameters of microwave devices. Study of operation algorithms and methods of calibration of scalar network analyzers.

Control work, its characteristics

The main purpose of the control work is to acquire the skills to determine the results of measuring the parameters of signals and infocommunication devices and evaluate their errors.

Title of the control work "The study of methods and means for measuring the parameters of signals and infocommunication devices and methods for estimating the measurement errors of these parameters". Content: solution of typical tasks to determine the parameters of signals and infocommunication devices and evaluate their errors.