**SYLLABUS**

**Fall semester 2022-2023 academic years**

**on the educational program “Antenna-feeder devices and electromagnetic wave propagation”**

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| **Discipline’s code** | **Discipline’s title** | **Independent work of students (IWS)** | **Number of credits** | | | | | **Number of credits** | **Independent work of student with teacher (IWST)** |
| **Lectures (L)** | **Practical training (PT)** | | **Laboratory (Lab)** | |
| 8B722 | Antenna-feeder devices and electromagnetic wave propagation | 1 | 1 | 1 | | 1 | | 5 | 1 |
| **Academic course information** | | | | | | | | | |
| **Form of education** | **Type of course** | **Types of lectures** | | | **Types of practical training** | | **Form of final control**  Writing | | |
| Full-time | Theoretical | Problematic, analytical | | | Mathematical task, laboratory work | |
| Lecturer | Turlykozhayeva Dana Abdikumarovna | | | | | | Writing | | |
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| **Aim of course** | **Expected Learning Outcomes (LO)\***  As a result of studying the discipline the undergraduate will be able to: | **Indicators of LO achievement (ID)**  (for each LO at least 2 indicators) |
| Formation of a system of knowledge, skills of using antenna-feeder devices for receiving and transmitting electromagnetic waves of the radio frequency range in wireless communication systems; and to teach students the mathematical and physical foundations of the propagation of electromagnetic waves in various media. | 1. Will know the theory of electromagnetic wave propagation and the basic principles of radio wave propagation in various media. | 1.1. To understand the mathematical model of fundamental electrodynamics  1.2 To know the laws of different radio ranges distribution in the atmosphere  1.3. To know the frequency bands of radio waves |
| 2. Antenna-feeder device operation basic principles of antenna technology know the basis and distinguish between their types. | 2.1. Receiver and transmitter antenna operation know the principles  2.2 Antenna design, polarization, bandwidth,  range, direction, depending on installation  be able to classify  2.3. To know the main types of antennas |
| 3. Basic antenna devices electrodynamic, frequency characteristics and basis of analog and digital devices to  know. | 3.1. To know receiver and transmitter  radio engineering antennas  characteristics (route scheme,  amplification, living wave, directional  understand and the coefficients of influence)  3.2. To know frequency dependent  electrodynamic characteristics.  3.3. To know the basic characteristics of antennas |
| 4. Phase Antenna Arrays (FAT), MIMO, to know the principles of satellite dish operation | 4.1. Basis and types of FAT  to know, to determine their features  know  4.2 MIMO, smart antennas understand and know the basis, understand  4.3. To know the basis of antennas, their advantages, know the features |
| 5. Ability to work with radio frequency measuring instruments and computer simulation programs. | 5.1 To know the basic measuring instruments of different ranges, additional instruments and be able to use them as much as possible  5.2 Knowledge and ability to use basic software packages for modeling antenna devices  5.3 To understand the construction of simple antennas |
| **Prerequisites** | Electricity and magnetism; Fundamentals of radio engineering and telecommunications; Fundamentals of vector and tensor analysis. | |
| **Post requisites** | Graduate work | |
| **Information resources** | **Literature:**  1.Г.А. Ерохин, О.В. Чернышев, Н.Д. Козырев. Антенно-фидерные устройства и распространение радиоволн. Учебник для вузов. – М: Горячая линия- Телеком, 2004.-491 с: ил. ISBN 5-93517-092-2  2.Карл Ротхаммель. Антенны. Том 1.  3.А.П. Пудовкин, Ю.Н. Панасюк, А.А. Иванков. Основы теории антенн. Учебно- методическое пособие,- ТГТУ. Тамбов, 2011.  4.Д.И. Воскресенский, В.Л. Гостюхин, В.М. Максимов, Л.И. Пономарев. Устройства СВЧ и антенны. Учебно-методическое пособие, - М: Радиотехника, 2006.  5.Першин В.Т. Основы современной радио электроники. Ростов Н\Д: Феникс, 2009, 541с.  6.Курыцин С.А. телекоммуникационные технологии и системы. М.: «Академия», 2008, 304с.  7.Томаси У. Электронные системы связи. М.: Техносфера, 2009. – 1360с.  8.Романюк В.А. Основы радиосвязи М.: Юрайт, 2011. – 287с.  9.Макаров С.Б. Телекоммуникационные технологии. – М.: «Академия», 2008.-256с.  10.Арслан Х. Чен ЧЖ.Н., Бендетто М. Сверхширокполосная безпроводная связь. – М.: Техносфера, 2012. – 640с. | |
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| **Academic policy of the course in the context of university moral and ethical values** | **Academic Behavior Rules:**  All students are required to register for the MOOC. The deadlines for completing the modules of the online course must be strictly observed in accordance with the schedule for studying the discipline. Leave in case of current MOOC or SPOC courses. f points! The deadline for each task is indicated in the calendar (schedule) for the implementation of the  **ATTENTION!** Failure to meet deadlines results in loss o content of the training course, as well as in the MOOC. Leave in case of current MOOC or SPOC courses.  **Academic values:**  - Practical trainings/laboratories, IWS should be independent, creative.  - Plagiarism, forgery, cheating at all stages of control are unacceptable.  - Students with disabilities can receive counseling at e-mail \*\*\*\*\*\*\*@gmail.com. |
| **Evaluation and attestation policy** | **Criteria-based evaluation:**  assessment of learning outcomes in relation to descriptors (verification of the formation of competencies in midterm control and exams).  **Summative evaluation:** assessment of work activity in an audience (at a webinar); assessment of the completed task. |

**CALENDAR (SCHEDULE) THE IMPLEMENTATION OF THE COURSE CONTENT:**

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| week | Topic name | Number of hours | Max.  score |
| **Module 1** | | | |
| 1 | **Lec 1.** Fundamentals of antenna technology. Electromagnetic waves (EMW). | 1 | 5 |
| 1 | **Sem 1.** EMW scale. Radio waves. | 1 | 5 |
| 1 | **Lab 1.** Familiarization with the basics of modeling antennas in the python environment | 2 | 5 |
| 2 | **Lec 2.** Electromagnetic field and mathematical model | 1 | 5 |
| 2 | **Sem 2.** Law of conservation of charge. Gauss's law. Full current, displacement current laws. | 1 | 5 |
| 2 | **Lab 2.** Study of monopole and dipole antennas | 2 | 5 |
| 2 | **IWST 1.** Maxwell's system of equations |  |  |
| 3 | **Lec 3.** Propagation of EMW of various ranges in free space. Radio wave propagation along the earth's surface. Influence of atmospheric layers i  heterogeneity of the earth's surface. | 1 | 5 |
| 3 | **Sem 3.** Radio wave propagation along the earth's surface. | 1 | 5 |
| 3 | **Lab 3.** Microstrip and patch antennas | 2 | 5 |
| 3 | **SIW 1.** Types of antenna |  |  |
| 4 | **Lec 4.** Plane electromagnetic waves. Longitudinal and transverse waves. Plane electromagnetic waves with an elliptical polarization. | 1 | 5 |
| 4 | **Sem 4.** The structure of the electromagnetic field of E- and H-waves. | 1 | 5 |
| 4 | **Lab 4.** Study of loop antennas | 2 | 5 |
|  | **IWST 2.** Wire and ribbon antennas |  |  |
| 5 | **Lec 5.** Coaxial and strip waveguides.  Attenuation of waves in metal waveguides. | 1 | 5 |
| 5 | **Sem 5.** Complex antennas consisting of half-wave vibrators. | 1 | 5 |
| 5 | **Lab 5.** Research of helical antennas | 2 | 5` |
| **Module 2** | | | |
| 6 | **Lec 6.** Radio engineering, physical characteristics and parameters of transmitting and receiving antennas. Purpose of transmitting antennas and their functions. | 1 | 5 |
| 6 | **Sem 6.** Transmitting antenna as a load for generator, its energy parameters. | 1 | 5 |
| 6 | **Lab 6.** Research on horn antennas | 2 | 5 |
| 7 | **Lec 7.** Transmitting radiation patterns antennas and their image in different coordinate systems. | 1 | 5 |
| 7 | **Sem 7.** Main lobe width and level side lobes. | 1 | 5 |
| 7 | **Lab 7.** Study of reflector antennas | 2 | 5 |
| 7 | **IWST 3.** Horn antennas |  |  |
|  | **LEVEL CONTROL 1** |  | **100** |
| 8 | **Lec 8.** The directivity and gain of the transmitting antenna. | 1 | 5 |
| 8 | **Sem 8.** The effective length of the receiving antenna. Effective opening area. | 1 | 5 |
| 8 | **Lab 8.** Study of reflector antennas | 2 | 5 |
| 8 | **IWS 2.** Reflection coefficients S11 and VSWR core wave |  |  |
| 9 | **Lec 9.** Noise temperature of receiving antenna | 1 | 5 |
| 9 | **Sem 9.** Noise temperature of receiving antenna | 1 | 5 |
| 9 | **Lab 9.** Research of hollow antennas | 2 | 5 |
| 10 | **Lec 10.** Fundamentals of the theory of antenna arrays | 1 | 5 |
| 10 | **Sem 10.** Phased array antenna - PAR | 1 | 5 |
| 10 | **Lab 10.** Investigation of antenna arrays | 2 | 5 |
| 10 | **IWST 4.** PAR with aperture control |  | 5 |
|  | **Module 3** |  |  |
| 11 | **Lec 11** Multiplication theorem for radiation patterns. Radiation field  rectilinear antenna array. | 1 | 5 |
| 11 | **Sem 11.** Graphical representation of the multiplier  antenna array | 1 | 5 |
| 11 | **Lab 11.** Investigation of antenna arrays | 2 | 5 |
| 12 | **Lec 12.** MIMO system and its main  principles | 1 | 5 |
| 12 | **Sem 12.** Types of MIMO Antennas | 1 | 5 |
| 12 | **Lab 12.** Exploring MIMO Antennas in Python | 2 | 5 |
| 12 | **IWST 5.** MIMO Antenna Correlation Coefficients |  |  |
| 13 | **Lec 13.**  Antennas in 5G | 1 | 5 |
| 13 | **Sem 13.** Massive MIMO Antennas | 1 | 5 |
| 13 | **Lab 13.** Study of fractal antennas | 2 | 5 |
| 13 | **IWS 3.** Modeling wire antennas in HFSS, CST programs |  |  |
| 14 | **Lec 14** Basic in antenna-feeder devices measuring instruments | 1 | 5 |
| 14 | **Sem 14.** Signal generators, spectrum analyzer and vector circuit principle of the analyzer | 1 | 5 |
| 14 | **Lab 14.** Study of "waveguide" antennas | 2 | 5 |
|  | **IWST 6.** Signal generators |  |  |
| 15 | **Lec 15.** In antenna-feeder devices basic simulation programs | 1 | 5 |
| 15 | **Sem 15.** In antenna-feeder devices features of the work of the main simulation programs | 1 | 5 |
| 15 | **Lab 15.** Antenna-feeder devices features | 2 | 5 |
| 15 | **IWST 7.** Basic in antenna-feeder devices |  |  |
|  | LEVEL CONTROL 2 |  | **100** |

Dean \_ Beisen N. A.\_\_

Head of Department \_Ibraimov M. K.\_\_

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