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## **SUMMARIES OF THE COURSES**

for the master's program

«Microwave and Terahertz Wireless Systems»

Educational direction

11.04.03 «Design and Technology of Electronic Means»

### **«Project Management»**

The discipline «Project management» is the base for the disciplines of the professional cycle of the educational program and is designed to prepare masters who will manage innovative projects and relevant departments of organizations in the digital economy. The subject of its study is the project as a process and object of management; methods and technologies of selection of projects for implementation taking into account the main organizational and commercial risks; methods and technologies of planning and project management and existing domestic and international standards in this area; methods of calculating the cost and determining the price of the project using modern pricing models; methods of assessing and managing the competitiveness of the product being created; methods and sources of project financing; commercialization of the results of project activities, taking into account cost-effectiveness estimates.

### **«Foundations of Micro and Nanotechnology for Radioelectronics»**

The main features of micro- and nanostructured materials used in radio electronics are studied on the basis of modern concepts of nanophysics and nanochemistry. The main technological processes of the formation of micro- and nanostructures, modern and promising control and measurement technologies, methods for quantitative and qualitative analysis of nanoscale structures are considered.

### **«Computational Electromagnetics»**

Discipline involves the study of physical bases and principles of numerical modeling of various microwave devices and antennas using finite-difference methods in the time and frequency domain, method of moments for wire and plane-layered structures, as well as using the mode-matching applied to the waveguide structures.

Various forms of writing boundary conditions for boundary problems of electrodynamics, algorithms for generating vector electric and magnetic fields values by the Lorentz potentials are considered.

### **«Foundations of Scientific Research»**

Discipline «Foundations of Scientific Research» is a basic part of a general academic Master's cycle. The discipline is directed to acquaint the students with the structure of scientific knowledge, with the methods of scientific research, with the functions of scientific theories and laws; it broadens their ideological outlooks; develops elaboration of criteria for scientific character and the requirements to be met by scientific research and its results.

### **«Computer Technologies of End-to-End Design»**

The subject «Computer Technologies of End-to-end Design» includes methods and techniques to design radioelectronic functional units based on modern information technologies of the end-to-end design as well as CAD/CAM complexes using these methods and technologies.

### **«Infocommunication Networks»**

On the basis of a tiered approach to the construction of open systems, the following is considered: seven-layer Open Systems Interconnection model, especially the physical realization of network communication, transmission and reception of data by means of the data link layer, local area network, the network layer as a means of building a large network, wireless network technology.

In the course, the following is studied: the functional layers of the communication process; functional-functional means of establishing, maintaining and disconnecting physical connections; the physical layer; data transfer protocols; routing and retransmission, multiplexing network connection, segmentation and consolidation; methods of transmission is given on the communication lines; typical network topology; communication devices; structure of local networking standards; switching methods; implementation of interworking; domain name system; WANs.

### **«CAD of Microwave Devices and Systems»**

The course is devoted to the modern of computer-aided of microwave devices and system. The important aspects of building receiver and transmitter models as the system level are considered. A special attention is paid at the design of microwave devices such as low noise amplifiers, oscillators, mixers, filters, antennas etc. The basic principles of designing microwave devices on microstrip transmission lines, which are suitable for computer-aided manufacturing by means of the printed circuit board and hybrid integrated circuit technologies, are studied. Design of filters, diplexers and power dividers is considered. While studying the course, the students learn consequentially the full cycle of electronic device design and realization from the target specification to release for production.

### **«Russian as a Foreign Language»**

The discipline is intended for education of master's degree non-philological foreign students, who have the bachelor diploma of Russian institute of higher education and have the knowledge of Russian Language corresponding to the B 2 level. The program includes requirements for language knowledge level in different types of speech activity as well as grammar and speech material.

The mastering of this program will allow the foreign students to handle their communicative needs in educational, social and cultural sphere, will produce the base for successful learning of special subjects, and, as a result – for successful presentation of a thesis.

The Russian Language course for master's degree students must ensure the forming of a graduate's communicative competence on the level sufficient for professional activity in Russian Language. The education is realized on the source of general scientific, country-specific, literary, social and political texts.

### **«Foreign Language»**

The purpose of the course «Foreign language» - training in practical knowledge of a foreign language (English, German, French), the criterion of which is the ability to use

the most common language means in the main types of speech activity: speaking, listening, reading and writing. The aim of the course is to master the ability to maintain communication in most situations that may arise in everyday and professional activities. The structure of the course is divided into the following aspects (modules): speaking practice and listening, reading, writing practice, translation practice and practical grammar. Modules differ in topics and lexical composition of educational and informational materials. Systematic improvement of all four language skills and basic grammatical topics is provided.

### **«Introduction to Wireless Systems»**

Studying the course, students learn physical foundations and design principles of wireless systems for data and energy transmission, gain an impression on main types of such systems, their evolution, applications, and future trends.

### **«Basics of Antenna Design»**

In the course, the classification of antennas is given, their main characteristics are considered: the radiation pattern (RP), the width of the RP, the far and near antenna zones, the antenna input impedance, the directivity factor, the radiation resistance, the bandwidth, the gain factor, the efficiency. The basic types of antennas are considered: dipole, monopole, loop and printed antennas. The concept of phased array antennas (PhAA) is given. The lectures use the latest advances in the development and application of antennas in the field of wireless microwave systems. The practical study is aimed to obtain basic skills in the design of antennas for communication systems.

### **«Passive Microwave Components and Devices»**

Studying the course is intended to familiarize students with microwave integrated circuit components, design principles and applications of passive microwave devices. Besides, it allows students to master basic practical skills in the design of microwave integrated circuits.

## **«Wireless Communication Systems»**

The basic principles of mobile communication systems, the features of the radio channel and the resulting limitations on the characteristics of wireless communication systems, estimation of the radio link budget, the features of propagation of radio waves on typical transmission paths, the structure and basic characteristics of mobile communication systems are considered.

## **«Active Microwave Devices»**

The course «Active Microwave Device» is focused on the basics of designing active devices such as microwave low-noise amplifiers, power amplifiers, and oscillators. Also, attention is paid to active elements and technologies providing improved performance, mass production and miniaturization of the devices. Practical study is aimed at obtaining elementary skills in designing devices used in receiver and transmitter microwave modules of communication systems.

## **«Introduction to Microwave Measurements»**

When studying the course, students learn about methods to measure main characteristics of passive and active microwave devices as well as antennas. They master skills of practical work with the state-of-the-art measurement equipment. The course comprises basics of power measurement, scattering parameters and noise figure measurements of microwave devices as well as measurement of antenna characteristics, signal spectrum analysis and measurement of the dielectric material parameters at microwaves.

## **«Metamaterials for Microwave and THz Applications»**

In the course, students study the main properties of metamaterials (artificial electromagnetic structures) designed for practical applications in microwave and THz frequency range. The most important properties of metamaterials due to their lefthandedness are used for a design of microwave devices with improved performance and enlarged functionality. The following devices are under considerations: resonators and filters based on a combination of transmission lines with negative and positive

dispersion, high impedance surfaces, multi-band passive devices, tunable devices, photonic band-gap metamaterials. The practical study focuses on obtaining basic skills for designing devices that are used in receiving modules of communication systems: miniature passive microwave devices, screening structures, printed antennas etc.

### **«Microwave Devices of Telecommunication Systems»**

The course «Microwave Devices of Telecommunication Systems» covers the design basics of microwave devices used in modern wireless communication systems. Practical exercises allow students to get the basic skills of designing miniature passive microwave devices, low-noise transistor amplifiers, power amplifiers, oscillators, and printed antennas.

### **«Academic Internship (Research Project (Acquiring Basic Research Skills))»**

#### **«Internship (Research Project)»**

#### **«Internship (Pre-degree Internship)»**

### **«State Final Examination»**

The State final attestation includes defense of the graduation qualification work. The State final attestation is the last mastering stage of the basic educational program.

The training level of graduates for performance of their professional tasks and compliance of their training with the requirements of the State Standard are assessed in the course of the State final attestation.

### **«Modern Problems of Radioelectronics»**

The discipline aims to acquaint students with modern achievements in the field of radio engineering and radio electronics in various areas: signal processing devices and navigation systems; microwave technology, antennas and devices; radio systems; laser technology in electronics; information satellite systems and technologies; telecommunications and intelligent networks; data transmission and protection in information systems; semiconductor electronics and nanoelectronic; design and

technology of electronic means; biomedical electronics; functional materials of micro- and nanoelectronics.

### **«Scientific Workshop»**

The purpose of the scientific seminar is to present the results obtained during the practice and preparation for the protection of WRC. The specific content of research plans together with the student, his supervisor and directed to the expansion and consolidation of professional knowledge received by students in the learning process, and the formation of practical skills of conducting independent scientific work in the fields of electronic circuits, devices, systems, design, constructions and technologies electronic equipment.