

State doctoral exam topics

ELECTRICAL ENGINEERING AND COMMUNICATIONS

Section Radioelectronics

1. Electrodynamics and Numerical Methods, Modeling of Electromagnetic Field

Electromagnetic fields - basic equations for particular types of fields. Methods for analytical solution of electromagnetic field. Numerical techniques for solving electromagnetic fields. Geometric and wave approach for solving fields. Simulation and modeling of electromagnetic field.

2. High Frequency and Microwave Technology

Waveguides and resonators. Passive circuit blocks of microwave technology - analysis, design. Active circuit blocks in the microwave band - analysis, design. Microwave measurements. Interactions of optical and microwave radiation. Modern millimeter and submillimetre technologies.

3. Antenna Techniques

The principles of radiation, internal and external approach. Parameters of antennas and antenna measurement. Antenna arrays - analysis and synthesis. Wire antennas. Conform antennas, patch antennas. Reflector antenna structures, lenses. Wideband antenna structures, frequency selective surfaces, PBG.

4. Propagation of Electromagnetic Waves

Radio transmission, link budget, losses, reflection, refraction in the atmosphere. Noise parameters, Planck's law of radiometry. The specific properties of the surface of the earth and the earth's atmosphere and their influence on wave propagation. Methodology for calculation of coverage in different frequency bands for fixed services. Methodology of mobile service planning in macro, micro and picocells. Measurement and coverage determination.

5. Optical Fibers and Wireless Systems

Optical fibers and waveguides, parameters, transmission characteristics. Measurement of the optical fiber and the optoelectronic measurement. Optical environment, nonlinear optics. Special optical fibers. Wireless optical communication. Communication in the visible spectrum.

6. Medical Applications of Optoelectronics, Electromagnetic Field and Microwave Technology

The interaction of electromagnetic fields with biological tissue. Thermotherapy, Hyperthermia. Modelling of fields - electromagnetic field distribution in the tissue. NMR, ultrasound and radiometric temperature measurement. Measurement of microwave thermotherapy, testing of applicators for microwave thermotherapy. Optoelectronic systems for medical diagnosis. Optical properties of biological tissues.

7. Signals and Systems

Characteristics of deterministic and random signals, signals in temporal and frequency domain. Orthogonal expansion of the signal. Correlation function of deterministic and random signals and its relationship to energy and power density spectrum. Analog and digital modulation.

8. Radio Communications

Entropy of the source, source coding. Channel capacity and channel coding. Linear block and convolutional codes. Digital modulation technique. Spread-spectrum communications.

9. Statistical Signal Processing

Principles of stochastic parameter estimation. Application of Maximum A Posteriori Probability and Maximum Likelihood estimation on coherent and non-coherent demodulation. Linear estimation and its application on radio-frequency signal filtration.

10. Radio Subsystems

Frequency lock loop FLL, phase lock loop PLL, delay lock loop DLL. Direct and indirect frequency synthesizers. Direct frequency synthesizer DDS.

11. Radio Systems

General schema of the radio communication system, capacity and conceptual design. Terrestrial and satellite radio and television broadcasting. Professional radio communication systems (radio-relay links, systems of terrestrial mobile service, cellular radio telephone systems). Radio-frequency measurement instruments: signal generators, RF voltmeters, Oscilloscopes, Spectral analyzers, RF and microwave network analyzers.

12. Radio Position Determination and Navigation

Radio system for measurement of angle of arrival and distance. Directional finder, VOR and TACAN. Distance Measuring Equipment DME. Doppler systems. Satellite navigation systems, principles of operation, errors and their sources, errors suppression methods. GPS and GLONASS.

13. Radar Systems

Principle of primary and secondary radar. Power budget, effective cross-sectional area, range. Digital processing of radar signals. Precision of range and angle estimation. Secondary surveillance radar in S mode, anti-collision system ACAS.

14. Optic Radiation, Electro-optics, Optoelectronics

Wave and photon representation. Optic radiation sources. Photon detectors, optical sensors, image sensors, AOTF, optical displays. Bulk and thin-film SLM and processor elements, optic amplifiers and switching elements, memories.

15. Optical information processing, photon metrology, physiological photonics

Optical processor systems - parallelisms of the process. Recording, transmission and reproduction of image information. Coding in TV. HVS, optic radiation impact to the human being and environmental aspects, solar energetics. Radiometry, photometry, colorimetry.

Elective Thematic Area (all sections)

Selection of a specific area should be based on the supervisor's recommendation, it should be related to the dissertation topic and concern the problems having been studied by the student from current scientific literature. The topic should be quoted in the application for the State Doctoral Examination.