PROGRAM
Entrance Examination
"Nanotechnology and Microsystem Technics "

Master's programs
"Nanotechnology and Materials for Micro- and Nanosystems"

The content of the program:

I. Explanatory Note

The purpose of the entrance examination is to establish upon entering the master's programs the level of the candidate's knowledge of subject-related educational and scientific materials and compliance with the training requirements of the state educational standard of higher education in "Nanotechnology and Materials for Micro- and Nanosystems".

Entrance examinations are held in the form of an interview with use of remote technologies.

The duration of the entrance examination is not to exceed 40 minutes.

The maximum score is 100 points and is the combined sum of the scores from the results of the interview component and the score for individual achievement.

The maximum amount of points for the interview component is 60 points. Two questions derived from program content comprise the interview component. Each question is scored from 0 to 20 points. Additionally, the level of knowledge of professional terminology in English is being evaluated from 0 to 20 points. The results of the evaluation interview are the sum of points earned for each question and for the level of knowledge of professional terminology demonstrated in English.

The maximum amount of points for the individual achievement component is 40 points and consists of assessing the following achievements: academic achievement (cumulative grade point average from previous post-secondary institutions of higher education, publications, participation in conferences, scientific achievements, achievements in educational and social activities (certificates, diplomas, etc.) from 0 to 20 points; Statement of Purpose from 0 to 10 points; and letter(s) of recommendation from 0 to 10 points total.

Candidate must earn a minimum of 20 points to be considered eligible for admission.

II. Examination Content Outline

- Basic types of substances in a nanocrystalline state and their properties
- Physical and chemical theory for nanoparticle origin
- Diffusion and kinetic processes of nanoparticle synthesis reactions
- Physical and chemical methods of nanoparticle synthesis
- Kinetic regularities for calculations of nanomaterial synthesis processes
- Electronic configuration of atom orbitals and the chemical bond types into solids
- Classification of micro and nano systems (0D, 1D, 2D, 3D), characteristic length of nanoobjects
- Self-organization of nanostructure
- Defects of crystal structure. The point defects. Equilibrium concentration of the point defects. Noneequilibrium defects and their nature
- Dislocations, their types, the parameters of dislocations. Interaction of dislocations
- Sources of dislocation appearance and energy of the formation.
- Concept of phase. Structure of clean elements and solid solutions. Classification of solid solutions.
- Equilibrium of phases in the multi component systems. I and II types of phase transitions
- Basic types of the state diagrams of binary systems. Polymorphous transformations
- Disintegration of the super saturated solid solutions
- Crystallization. Thermodynamics and crystallization kinetics
- Homogeneous and heterogeneous crystal origin in melt. Role of overcooling in crystallization processes.
- Crystal growth mechanisms. Directional crystallization
- Epitaxy growth. Mechanisms of growing an epitaxy layer
- Methods of obtaining bulk semiconductor and dielectric crystals.
- Methods of obtaining epitaxy layers and heteroepitaxy multilayer compositions.
- Diffusion. Phenomenological diffusion laws. Self-diffusion and heterodiffusion.
- Atom diffusion mechanisms. The diffusion under a concentration gradient field.
- Temperature and duration factors in a diffusion process. Reactive diffusion.
- Generation and recombination of nonequilibrium charge carriers.
- Life time, the diffusion path length, Photoconductivity, radiation recombination

- Methods for micro and nanosized objects investigation.
- Probe methods and different Microscopy methods for materials investigation.
- Methods for X-ray investigation. Evaluation of structure defects.
- Semiconductor devices. Diode, tunnel diode. Bipolar transistor
- BT based on MIS structure
- Heterotransistors with 2D electron gas
- Magnetic nanoparticles. Superparamagnetism
- Magnetic multilayers. Giant magnetoresistance

III.Recommended Reading

1. Johnson M., Magnetoelectronics, Elsevier Academic press, 2004
2. Piprek P., Optoelectronic Devices: Advanced simulation and analysis, Springer, 2005
3. John G. Webster, Halit Eren, Measurement, Instrumentation, and Sensors Handbook, Second Edition: Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement, CRC Press, 2014.