RUSSIAN-ARMENIAN UNIVERSITY (RAU)

Engineering and Physics Institute

Specialization «Electronics and Nanoelectronics»

PROGRAM SPECIFICATION

1. Programe Specialization:	Microelectronics and Nanoelectronics
2. Classifier	11.04.04
3. Awarded Qualification	Master's Degree:

4. Aims of the Program

The aim of the program is

- Preparation of students with the knowledge of the principles of electronics and nanoelectronics, and deep and specialized knowledge in physics, who will be ready to continue their career and/or education in both research centers and educational institutions, and also in the high-tech companies
- To acquaint students with modern electronics
- To give basic knowledge on modern methods of physics and mathematics.
- Develop the ability to make independent applied and research works
- Use acquired knowledge for solving interdisciplinary problems

5. Learning Outcomes

A. Professional knowledge and understanding

In the end of the program students will be able to

A1. represent the principles of modern programming languages for development and implementation of algorithms

A2. explain the physical and mathematical methods of the physical processes describing the research devises

A3. formulate basic protection of intellectual property provisions

A4. explain the stages of implementation of the work plan and technical programs

B. Practical professional skills

In the end of the program students will be able to

B1. develop characteristics of electronic devices, measurement methods and results of the analysis implementation

B2. communicate with the professional community by technical verbal and written English

B3. implement collection, processing and analyzing of the relevant scientific literature,

B4. develop technical documents of operated electronic devices

B5. carry out research and pedagogical activities

C. General (transferable) skills

In the end of the program students will be able to

C1. implement the organization and management of professional staff work

C2. prepare reports, reviews, essays and printings ased on the results of scientific research

C3. apply knowledge of physical phenomena in the design of new research methods and measuring devices

6. Program curriculum

Attached

7. Curriculum Map:

Attached

8. Evaluation forms

- intermediate and final exams, tast,
- assessment of independent works,
- Preparation of essays,
- Master thesis defense.

9. Future Career Opportunities for Alumni

Graduates of the program can work in the electronics-based technology and computer software companies and enterprises and capture the following positions:

High-tech companies

- Chief Engineer
- Engineer-Constructor
- Micro and Nanoelectronics Engineer
- Developer-Designer

Advisory bodies

- Electronics and nanoelectronics based technology consultant

Departments and chairs of electronics and physics

- Junior Researcher
- developer, programmer
- Laboratory assistant, Senior Laboratory Assistant
- Engineer
- Head of Educational Laboratory

Graduates of the program can continue their studies at the post-graduate courses in physics, electronics and related professions of the RAU, YSU, NAS RA and other organizations.

As the fields of professional activity can be educational institutions (Russian-Armenian University, Yerevan State University, National Polytechnic University of Armenia, Yerevan State Medical University, Armenian State Pedagogical University), scientific institutes (Institute for Physical Research, Institute of Radiophysics and Electronics) IT companies and more.

10. Resources and Forms of Teaching Assistance

The following auxiliary resources are used during the learning process:

- Laboratories equipped with modern teaching devices
- Computers equipped with modern software
- Printed literature
- Electronic resources
- Scientific laboratories of IPR (base instituite of RAU) equipped with modern equipment

11. Educational standards or software guidelines that have been used to develop the program

- RF State Educational Standard "Electronics, Radio Engineering and Communication"
- National Framework for Educational Qualifications of RA
- TEMPUS "ARMENQA" project

12. Additional information of the project

The program is an interdisciplinary course of physics and engineering disciplines:

EDUCATIONAL PLAN MAP OF THE ELECTRONICS AND NANOELECTRONICS PROGRAM

Learning Outcomes of the Program

A. Professional knowledge and understanding		**B. Practical professional skills**	
A1	represent the principles of modern programming languages for development and implementation of algorithms	B1	develop characteristics of electronic devices, measurement methods and results of the analysis implementation
A2	explain the physical and mathematical methods of the physical processes describing the research devises	B2	communicate with the professional community by technical verbal and written English
A3	formulate basic protection of intellectual property provisions	B3	implement collection, processing and analyzing of the relevant scientific literature,
A4	explain the stages of implementation of the work plan and technical programs	B4	develop technical documents of operated electronic devices
A5		B5	carry out research and pedagogical activities
A6		B6	
C. General (transferable) skills			
C1	implement the organization and management of professional staff work	C4	
C2	prepare reports, reviews, essays and printings ased on the results of scientific research	C5	
C3	apply knowledge of physical phenomena in the design of new research methods and measuring devices		

Name of educational module:	Credits	Learning Outcomes of the Program																							
		A 1	A 2	A 3	A 4	A 5	A 6			B 1	B 2	B 3	B 4	B 5	B 6	B 7	B 8		C 1	C 2	C 3	C 4	C 5		
I. HUMANITARIAN EDUCATIONAL BLOCK																									
Professional English	**8**	√				√						√													
Academic Writing	**4**	√	√				√					√										√			
II. GENERAL PROFESSIONAL COURSE CURRICULUM																									
Integrated Photonic Devices and Circuits	**6**	√									√										√				
Numerical Methods in Physics	**6**	√									√										√				
Coursework Project on Numerical Methods	**6**	√									√		√								√				
Introduction to Quantum Communication	**6**	√									√										√				
III. CURRICULUM OF SPECIALIZATION COURSES																									
Quantum Nanostructures	**6**	√									√										√				
Optical Properties of Quantum Dots	**6**	√									√										√				
Laboratories in Optics Research	**6**	√									√										√				
Modeling of Nanostructures	**6**	√									√										√				
Semiconductor Nanoelectronics	**6**	√									√										√				
IV. RESEARCH STRUCTURE																									
Research Project 1	**8**				√						√									√	√	√			
Research Project 2	**8**			√	√					√												√			
Research Project 3	**8**			√	√					√												√			
Finalization of Research Project	**20**				√					√										√					
Defense of master's thesis	**10**				√					√										√					

Professional English

This course is designed to develop students' proficiency in English for professional and academic purposes. It focuses on enhancing speaking, listening, reading, and writing skills in contexts relevant to students' fields of study and future careers. Key topics include technical vocabulary, academic writing, presentation skills, formal correspondence, and effective communication in multicultural environments. The course aims to prepare students for successful interaction in international professional and academic settings.

Academic Writing

This course is aimed at developing students' skills in academic writing in English, with a focus on structure, clarity, and coherence. It covers essential elements such as thesis statements, paragraph development, argumentation, citation styles, and academic vocabulary. Through guided practice, students learn to write essays, reports, abstracts, and research papers in accordance with academic conventions. The course prepares students to effectively communicate their ideas in written form within an academic context.

Integrated Photonic Devices and Circuits

This course provides an in-depth introduction to the principles, design, and application of integrated photonic devices and circuits. It covers the fundamentals of light propagation in waveguides, optical materials, and fabrication techniques used in photonic integration. Students will explore key components such as modulators, detectors, filters, and interferometers, and learn how these elements are integrated into photonic circuits for applications in communications, sensing, and signal processing. The course also addresses emerging technologies in silicon photonics and quantum photonics, preparing students for research and development in the rapidly evolving field of integrated optics.

Numerical Methods in Physics

The aim of the course is to familiarize students with Wolfram Mathematica Programm and the use of the Mathematica environment as a symbolic and numerical tool for solving physics problems. The fundamentals of high-level programming are considered. The course gives examples of solving problems using the Wolfram language from various areas of physics:

mechanics, electricity, quantum mechanics, solid state theory, and so on. Examples are examined with detailed code parsing and the use of important techniques, such as the definition of functions, procedures, templates, etc., are questions related to character calculations. Such questions as special functions, differential operators, coordinate systems, etc. are considered.

Introduction to Quantum Communication

This course provides an overview of the principles and technologies underlying quantum communication. Students will explore fundamental concepts such as quantum bits (qubits), quantum entanglement, quantum key distribution (QKD), and quantum teleportation. The course emphasizes both theoretical foundations and practical implementations, offering insights into emerging applications in secure communication and quantum networks.

Quantum nanostructures

The purpose of this course is to introduce students to physical processes in quantum nanostructures in the presence of external electric and magnetic fields. The behavior of one-electron, impurity, and exciton systems under the influence of external fields in quantum wells, wires and dots is studied. The mechanisms governing the optical, spin, and electrodynamic characteristics of quantum nanostructures are determined. Particular attention is paid to the behavior of particles in quantum dots with nontrivial geometry. Approximate analytical methods for describing quantum dots with different geometries are presented. The role of electromagnetic potentials in quantum mechanics is discussed. On the example of the Aharonov-Bohm effect in a quantum ring, the problem of nonlocality of the interaction in quantum mechanics is considered.

Optical Properties of Quantum Dots

The purpose of teaching the discipline is to introduce students to optical phenomena occurring in semiconductor quantum dots, as well as to the mechanisms of intraband and interband (direct and indirect) transitions in the above systems. Preparation of future specialists in the field of optoelectronics with the theoretical and applied necessary knowledge.

Laboratories in Optics Research

This course offers hands-on experience in advanced optical experiments relevant to contemporary research. Students will conduct laboratory work involving laser systems, interferometry, spectroscopy, optical fibers, and photonic devices. Emphasis is placed on

experimental design, data analysis, and scientific reporting, preparing students for independent research in optics and photonics.

Modeling of Nanostructures

This course introduces students to theoretical and computational methods for modeling nanoscale structures and phenomena. It covers quantum mechanical principles, simulation techniques (such as density functional theory and molecular dynamics), and their application to the analysis of electronic, optical, and mechanical properties of nanomaterials. The course equips students with practical skills for research and development in nanotechnology and materials science.

Semiconductor nanoelectronics

The purpose of this course is to introduce students to the basics of semiconductor nanoelectronics. Such concepts as size quantization and confining potential are introduced. The types of quantum nanostructures are discussed in detail: quantum wells, quantum wires, quantum dots. Various mechanisms for the growth of quantum nanostructures are described. The possibility of controlling the energy spectrum of charge carriers in semiconductor nanostructures is shown. Optical properties of quantum nanostructures are discussed, as well as mechanisms for controlling the optical characteristics of quantum wells, wires, and dots. A detailed discussion of the behavior of impurity and exciton systems in low-dimensional semiconductors is presented. The principles of operation of heterostructural lasers, quantum dot-LED’s, one-electron transistors are discussed.