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| MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION | | | | | | | | | | | | | | | | | | | | | |
| Federal State Budget Educational Institution of Higher Education  «MIREA – Russian Technological University» | | | | | | | | | | | | | | | | | | | | | |
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| **Institute of Physics and Technology** | | | | | | | | | | | | | | | | | | | | | |
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| Working program of the practice | | | | | | | | | | | | | | | | | | | | | |
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| **Training practice** | | | | | | | | | | | | | | | | | | | | | |
| **Research work (acquisition of primary research skills)** | | | | | | | | | | | | | | | | | | | | | |
|  | Department leading the training | | | | | |  | | **Department of Nanoelectronics** | | | | | | | | | | | | |
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|  | Direction of training | | | | | | |  | **11.04.04 Electronics and nanoelectronics** | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Profile | | | | | | |  | **Engineering of modern materials for information technology, renewable energy and sensing** | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |
|  | Qualification | | | | |  |  |  | **Master** | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Form of education | | | | |  |  |  | **Full-time** | | | | | | | | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Total labor intensity | | | |  |  |  |  | **6 credits** | | | | | | | | | |  |  |  |
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| **Distribution of discipline hours and forms of intermediate certification by semesters** | | | | | | | | | | | | | | | | | | | | | |
| Semester | | Credits | Distribution of hours | | | | | | | | | | | | | | | Forms of intermediate attestation | | |  |
| Total | Lectures | | | | Laboratory work | | | Practical classes | Independent work of students | | Contact work during practice and (or) certification | | | Control of training |  |
| 2 | | 6 | 216 | 0 | | | | 0 | | | 0 | 150,25 | | 48 | | | 17,75 | Test with an assessment | | |  |
| including for practicing practical skills | | | | 0 | | | | 0 | | | 0 | 75 | | 0 | | | 0 |  | | |  |
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|  | |  |  | стр. 2 |
| The program was made by: |  |  |  |  |
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| *Doctor of Science in Physico-mathematical Sciences, Docent L. Fetisov \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* | | | | |
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| Working program of the practice | | |  |  |
| **Research work (acquisition of primary research skills)** | | | | |
|  |  |  |  |  |
| it is developed in accordance with FSES HE: | | |  |  |
| Federal State Educational Standard of Higher Education - Magistracy in the Direction of training 11.04.04 Electronics and nanoelectronics (order of the Ministry of Science and Higher Education of the Russian Federation from 22.09.2017 г. № 959) | | | | |
|  |  |  |  |  |
| it is based on the curriculum: | | |  |  |
| Direction of training: 11.04.04 Electronics and nanoelectronics  profile: «Engineering of modern materials for information technology, renewable energy and sensing» | | | | |
|  |  |  |  |  |
| The working program was approved at the meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
|  |  |  |  |  |
| Minutes of the department meeting from 02.03.2021 № 3  Head of the Department A. Sigov \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | |

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| **Approval of the WPD for execution in the next academic year** | | | | |
|  |  |  |  |  |
| The working program was revised, discussed and approved for execution in the 2022-2023 academic year at a meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
|  |  |  |  |  |
|  | Minutes of the department meeting from \_\_\_\_\_\_\_\_\_ 2022. № \_\_  Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
|  |  | | **Signature Printed name** | |
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| **Approval of the WPD for execution in the next academic year** | | | | |
|  |  |  |  |  |
| The working program was revised, discussed and approved for execution in the 2023-2024 academic year at a meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
|  |  |  |  |  |
|  | Minutes of the department meeting from \_ \_\_\_\_\_\_\_\_\_\_ 2023. № \_\_  Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
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| **Approval of the WPD for execution in the next academic year** | | | | |
|  |  |  |  |  |
| The working program was revised, discussed and approved for execution in the 2024-2025 academic year at a meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
|  |  |  |  |  |
|  | Minutes of the department meeting from \_\_\_\_\_\_\_\_ 2024. № \_\_  Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
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| **Approval of the WPD for execution in the next academic year** | | | | |
|  |  |  |  |  |
| The working program was revised, discussed and approved for execution in the 2025-2026 academic year at a meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
|  |  |  |  |  |
|  | Minutes of the department meeting from \_\_\_\_\_\_\_\_ 2025. № \_\_  Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
|  |  |  | **Signature Printed name** | |

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| **1. OBJECTIVES OF MASTERING THE PRACTICE** | | | | | |
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| "Research work (acquisition of primary research skills)" aims to form, consolidate and develop the practical classes of skills and competencies provided for by this work program in accordance with the requirements in the Direction of training 11.04.04 Electronics and nanoelectronics, taking into account the specifics of the profile - «Engineering of modern materials for information technology, renewable energy and sensing".  Practical training during practice is organized by the direct implementation of certain types of work by students related to future professional activities. | | | | | |
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| **2. THE PLACE OF PRACTICE IN THE STRUCTURE OF THE EDUCATIONAL PROGRAM** | | | | | |
|  | Direction of training: |  | 11.04.04 Electronics and nanoelectronics | | |
|  |
|  | Profile: |  | Engineering of modern materials for information technology, renewable energy and sensing | | |
|  |  |  |
|  | Block: |  | Practice | | |
|  |  |  |
|  | Part: |  | Mandatory part | | |
|  |  |  |
|  | Total labor intensity: |  | 6 credits (216 academic hour). | | |
|  |  |  |
|  |  |  |  |  |  |
| **3. KIND, TYPE AND METHOD OF PRACTICE** | | | | | |
|  | Kind of practice: |  | Training practice | | |
|  |  |  |
|  | Type of practice: |  | Research work (acquisition of primary research skills) | | |
|  |  |  |
| The method(s) of conducting the practice are determined in accordance with the federal state educational standard. If the standard does not regulate the method of practice, then it is carried out stationary. | | | | | |
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| **4. PLACE AND TIME OF THE PRACTICE** | | | | | |
| "Research work (acquisition of primary research skills)" areas of training 11.04.04 Electronics and nanoelectronics is carried out on the basis of structural divisions of RTU MIREA or in an organization carrying out activities in the profile of the corresponding educational program (hereinafter referred to as a specialized organization), including a structural unit a specialized organization, designed for practical training, on the basis of an agreement concluded between an educational organization and a specialized organization. | | | | | |
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| **5. THE STUDENT’S COMPETENCIES FORMED AS A RESULT OF MASTERING THE PRACTICE** | | | | | |
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| As a result of mastering the practice, the student must master the following competencies: | | | | | |
| **UC-1** - Capable to carry out a critical analysis of problem situations on the basis of a systematic approach, develop a strategy of action | | | | | |
| **GPC-2** - Capable to apply modern research methods, present and argumentatively defend the results of the work performed | | | | | |

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| **THE PLANNED RESULTS OF THE INTERNSHIP CHARACTERIZING THE FORMATION OF COMPETENCIES** | | |
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| **UC-1 : Capable to carry out a critical analysis of problem situations on the basis of a systematic approach, develop a strategy of action** | | |
|  |  |  |
| **UC-1.1 : Analyzes the problem situation as a system, identifying its components and the relationships between them** | | |
| **To know:** | | |
| - a systematic approach to solving problems | | |
| **Be able to:** | | |
| - to search, critically analyze and synthesize information, to apply a systematic approach to solving the tasks | | |
| **Possess:** | | |
| - the methodology of a systematic approach to solving the tasks | | |
|  |  |  |
| **UC-1.2 : Identifies gaps in information needed to solve the problematic situation; critically assesses the reliability of information sources** | | |
| **To know:** | | |
| - methods of searching, collecting and processing information | | |
| **Be able to:** | | |
| - to carry out critical analysis and synthesis of information obtained from various sources | | |
| **Possess:** | | |
| - methods of search, collection and processing, critical analysis and synthesis of information | | |
|  |  |  |
| **GPC-2 : Capable to apply modern research methods, present and argumentatively defend the results of the work performed** | | |
|  |  |  |
| **GPC-2.1 : Applies modern research methods in the field of electronics** | | |
|  |  |  |
| **To know:** | | |
| - basic measurement methods in experimental research in the field of electronics | | |
| **Be able to:** | | |
| - perform measurements of basic physical quantities | | |
| **Possess:** | | |
| - skills of performing experimental research by observation | | |
|  |  |  |
| **GPC-2.2 : Is able to present the results of work** | | |
|  |  |  |
| **To know:** | | |
| - principles of presentation of research results | | |
| **Be able to:** | | |
| - highlight the main results of research activities | | |
| **Possess:** | | |
| - skills of analyzing the main results of research activities | | |
|  |  |  |
| **AS A RESULT OF THE INTERNSHIP, THE STUDENT MUST** | | |
|  |  |  |
| **To know:** | | |
| - methods of searching, collecting and processing information | | |
| - principles of presentation of research results | | |
| - basic measurement methods in experimental research in the field of electronics | | |
| - a systematic approach to solving problems | | |
| **Be able to:** | | |
| - perform measurements of basic physical quantities | | |

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| - to carry out critical analysis and synthesis of information obtained from various sources | | | | | |
| - highlight the main results of research activities | | | | | |
| - to search, critically analyze and synthesize information, to apply a systematic approach to solving the tasks | | | | | |
| **Possess:** | | | | | |
| - skills of analyzing the main results of research activities | | | | | |
| - the methodology of a systematic approach to solving the tasks | | | | | |
| - methods of search, collection and processing, critical analysis and synthesis of information | | | | | |
| - skills of performing experimental research by observation | | | | | |
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| **6. STRUCTURE AND CONTENT OF THE PRACTICE** | | | | | |
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| During the training sessions, the organization ensures the development of students’ teamwork skills, interpersonal communication, decision-making and leadership qualities. | | | | | |
| **Code** | **Name of sections and topics /type of classes/** | | **Semester** | **Hours** | |
| **1. Organizational and preparatory section** | | | | | |
| **1.1** | **Organizational meeting (CWC).** Acquaintance with the purpose of the practice, the main stages of the practice, the places of the practice, the issuance of assignments for the practice | | 2 | 2,754 | |
| **1.2** | **Occupational Safety and Health Coaching (CWC).** Occupational safety and health briefing | | 2 | 1 | |
| **2. Obtaining practical skills, reviewing materials and forming an internship report** | | | | | |
| **2.1** | **Completing assignments aimed at obtaining practical training skills (IWS).** Collection and systematization of literature data. | | 2 | 20 (including 15 for practicing practical skills) | |
| **2.2** | **Performing tasks aimed at obtaining practical training skills (IWS).** Planning, preparation and execution of a practical assignment | | 2 | 90 (including 50 for practicing practical skills) | |
| **2.3** | **Analysis of information and formation of a practical training report (IWS).** Processing and analysis of the results of the internship Preparation of the practice report. | | 2 | 40,25 (including 10 for practicing practical skills) | |
| **2.4** | **Study excursions (CWC).** Visiting leading enterprises, scientific organizations, leading laboratories of RTU MIREA in the Direction of training | | 2 | 20 | |
| **2.5** | **Seminar (CWC).** Overview lectures by leading scientists and specialists on modern problems of electronics and microsystem technique | | 2 | 24 | |
| **3. Intermediate certification (test with an assessment)** | | | | | |
| **3.1** | **Preparation for the intermediate certification (Test with an assessment).** | | 2 | 17,75 | |
| **3.2** | **Contact work with the teacher during the intermediate certification (CWC).** | | 2 | 0,25 | |
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| **7. EVALUATION MATERIALS** | | | | | |
|  |  |  |  |  |  |
| **7.1. List of competencies** | | | | | |
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| The list of competencies that the program is aimed at mastering «Research work (acquisition of primary research skills)», | | | | | |

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| with an indication of the results of their formation in the process of mastering the educational program, presented in paragraph 3 of this work program | | | | | |
| **7.2. Typical control questions and tasks** | | | | | |
|  |  |  |  |  |  |
| Section 1  1.The value of the voltage in the power grid.  2.The problem of grounding devices and installations.  3.The sequence of switching on and off of devices and installations.  4.Handling of chemical reagents.  Section 2  1. Types of scientific publications.  2. Scopus systems, Web of Science, RSCI  3. «Antiplagiat» System  4. Processing of experimental results.  5. Methods for determining the errors of the results of the study.  6. Suggest a methodology for conducting an experiment in the subject area of practical training.  7. Suggest a block diagram of an experimental setup in the subject area of practical training.  8. What duties were performed during the internship? | | | | | |
| **7.3. Fund of evaluation Materials** | | | | | |
|  |  |  |  |  |  |
| A complete list of evaluation materials is provided in the Appendix 1. | | | | | |
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| **8. MATERIAL, TECHNICAL, EDUCATIONAL AND METHODOLOGICAL SUPPORT OF THE DISCIPLINE (MODULE)** | | | | | |
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| **8.1. MATERIAL AND TECHNICAL SUPPORT OF THE INTERNSHIP** | | | | | |
|  |  |  |  |  |  |
| **Name of premises** | | | | **List of main equipment** | |
| Classroom for lectures and seminars, group and individual consultations, ongoing monitoring and intermediate certification | | | | Multimedia equipment, specialized furniture, sets of demonstration equipment and educational and visual aids that provide thematic illustrations. | |
| A room for independent work of students | | | | Computer equipment with the ability to connect to the Internet and provide access to the electronic information and educational environment of the organization. | |
| Practice bases | | | | Equipment and technical means of training that allow you to perform certain types of work provided for by the assignment for practice. | |
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| **8.2. LIST OF SOFTWARE** | | | | | |
| 1. |  | Microsoft Windows. Contract No.32009183466 from 02.07.2020. | | | |
| 2. |  | Microsoft Office. Contract No.32009183466 from 02.07.2020. | | | |
| 3. |  | Comsol Multiphysics. Sublicense Contract No.31705027784 from 12.05.2017. | | | |

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| 4. |  | LabVIEW. Contract No. 0373100029519000161 from 10.12.2019. | | |
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| **8.3. RECOMMENDED LITERATURE** | | | | |
|  |  |  |  |  |
| **8.3.1. Basic literature** | | | | |
| 1. |  | Shchuka A. A., Sigov A. S. Elektronika v 4 ch. CHast’ 3. Kvantovaya i opticheskaya elektronika [Electronics resource]:Uchebnik dlya vuzov. - Moskow: Yurajt, 2021. - 117 p – Access mode: https://urait.ru/bcode/470590 | | |
| 2. |  | Gulyaev Yu. V., Ivanov V. I., Luchnikov P. A., Sigov A. S., Surzhikov A. P. Osnovy konstruirovaniya i tekhnologii proizvodstva radioelektronnyh sredstv. Integral’nye skhemy [Electronic resource]:Uchebnik dlya vuzov. - Moskva: Yurajt, 2021. - 460 p– Access mode: https://urait.ru/bcode/470122 | | |
| 3. |  | Shchuka A. A., Sigov A. S. Elektronika v 4 ch. CHast’ 2. Mikroelektronika [Electronic resource]: Uchebnik dlya vuzov. - Moskva: YUrajt, 2021. - 326 p– Access mode: https://urait.ru/bcode/470589 | | |
| 4. |  | Sherstyuk N. E., Gladyshev I. V., Kuznecov V. V. Metodicheskie ukazaniya po vypolneniyu vypusknoj kvalifikacionnoj raboty bakalavra [Electronic resource]:. - M.: RTU MIREA, 2021. - – Access mode: https://library.mirea.ru/secret/11062021/2713.iso | | |
| 5. |  | Kapustin V. I., Sigov A. S. Tekhnologii proizvodstva i kontrol’ kachestva nanomaterialov i nanostruktur [Electronic resource]:uchebnoe posobie. - M.: MIREA, 2017.- – Access mode: http://library.mirea.ru/secret/21022018/1647.iso | | |
| 6. |  | SHCHuka A. A., Sigov A. S. Elektronika v 4 ch. CHast’ 1. Vakuumnaya i plazmennaya elektronika [Electronic resource]:Uchebnik dlya vuzov. - Moskow: YUrajt, 2020. - 172 s – Access mode: https://urait.ru/bcode/451115 | | |
| 7. |  | Horin I. A. Tekhnologii elektronnoj komponentnoj bazy:uchebnoe posobie. - Saratov: Aj Pi Er Media, 2018. - 277 p. | | |
| 8. |  | Abdullaev D. A., Milovanov R. A., Horin I. A., i dr. Issledovanie sistem mnogourovnevoj metallizacii IS na ustanovke Quanta 3D DualBeam [Electronic resource]: metod. ukazaniya. - M.: MIREA, 2018. - – Access mode: http://library.mirea.ru/secret/25052018/1709.iso | | |
| 9. |  | Shchuka A. A., Sigov A. S. Elektronika v 4 ch. CHast’ 4. Funkcional’naya elektronika [Electronic resource]:Uchebnik dlya vuzov. - Moscow: Yurajt, 2020. - 183 p – Access mode: https://urait.ru/bcode/451677 | | |
| 10. |  | Shchuka A. A., Sigov A. S. Nanoelektronika [Electronics resource]:Uchebnik dlya vuzov. - Moskow: Yurajt, 2021. - 297 p– Access mode: https://urait.ru/bcode/470007 | | |
|  |  |  |  |  |
| **8.3.2. Additional literature** | | | | |
| 1. |  | Shchuka A. A., Sigov A. S. Elektronika:Uchebnik dlya akadem. bakalavriata. - M.: Yurajt, 2016. | | |
| 2. |  | Pevtsov E. F., Krutov V. V. Osnovy avtomatizirovannogo proektirovaniya SVCH ustrojstv i sistem [Electronic resource]:uchebnoe posobie. - M.: RTU MIREA, 2018.- – Access mode: http://library.mirea.ru/secret/06032019/1975.iso | | |
| 3. |  | Gladyshev I. V., Fetisov L. Yu., Yurasov A. N. Matematika v fizicheskih zadachah:uchebnoe posobie. - M.: MIREA, 2020. - 162 p. | | |
| 4. |  | Yurasov A. N., Yashin M. M., Levina E. Yu. Izbrannye glavy fiziki kondensirovannogo sostoyaniya:uchebnoe posobie. - M.: RTU MIREA, 2021. - 105 p. | | |
| 5. |  | Demenkova T. A., Pevtsov E. F. Diagnostika cifrovyh ustrojstv [Electronic resource]:uchebnoe posobie. - M.: MGTU MIREA, 2015.- – Access mode: http://library.mirea.ru/secret/e\_1156.iso | | |
| 6. |  | Pevtsov E. F., Tarasov I. E., Minnebaev V. M. Avtomatizirovannoe proektirovanie cifrovyh skhem [Electronic resource]: uchebnoe posobie. - M.: MIREA, 2016.- – Access mode: http://library.mirea.ru/secret/ab/1243.iso | | |

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| 7. |  | Pevtsov E. F., Demenkova T. A., Al’-Natah R. I. Osnovy modelirovaniya i proektirovaniya MEMS v SAPR CoventorWare [Electronic resource]:uchebnoe posobie. - M.: MIREA, 2016.- – Access mode: http://library.mirea.ru/secret/ab/1242.iso | | |
| 8. |  | Vorotilov K. A., Muhortov V. M., Sigov A. S. Integrirovannye segnetoelektricheskie ustrojstva:. - M.: Energoatomizdat, 2011. - 174 p. | | |
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| **8.4. RECOMMENDED LIST OF MODERN PROFESSIONAL DATABASES AND INFORMATION REFERENCE SYSTEMS** | | | | |
| 1. |  | Information and legal portal GARANThttp:// www.garant.ru | | |
| 2. |  | Electronic fund of legal and regulatory technical documentation Techexpert http://www.docs.cntd.ru | | |
| 3. |  | NanoNewsNet.ru- non-commercial on-line publication dedicated to the nanoindustry http://www.old.nanonewsnet.ru | | |
| 4. |  | Nanometer - Nanotechnology communityhttp://www.nanometer.ru | | |
| 5. |  | Information portal «Populyarnye nanotehnologii» http://www.popnano.ru | | |
| 6. |  | Russian Foundation for Basic Research https://www.rfbr.ru | | |
| 7. |  | Information portal Russian Science Foundation http://www.rscf.ru | | |
| 8. |  | COMSOL Multiphysics® Software for multiphysical modelinghttps://www.comsol.ru | | |
| 9. |  | Stephen Wolfram: Official Website http://www.stephenwolfram.com | | |
| 10. |  | Wolfram: computing and knowledge, hand to handhttp://www.wolfram.com | | |
| 11. |  | Scientific Electronic Library http://www.elibrary.ru | | |
| 12. |  | Natural Science educational Portal http://www.en.edu.ru | | |
| 13. |  | ХиМик.ru - website about chemistry http://www.xumuk.ru | | |
| 14. |  | Ministry of Science and Higher Education of the Russian Federation  https://www.minobrnauki.gov.ru | | |
| 15. |  | Foundation for the Promotion of Innovation  http://www.fasie.ru | | |
| 16. |  | Information portal of the international citation system “Web of Science”  https://www.apps.webofknowledge.com | | |
| 17. |  | Information portal of the international citation system Scopus  https://www.scopus.com | | |
| 18. |  | The magazine portal of the A.F. Ioffe Institute of Physics and Technology  https://www.journals.ioffe.ru | | |
| 19. |  | Russian Technological Journal  https://www.rtj.mirea.ru | | |
| 20. |  | Information and reference portal of scientific publications of domestic and foreign authors «Google Academy»  https://www.scholar.google.ru | | |
| 21. |  | Simiconductor Industry Association  https://www.semiconductors.org | | |
| 22. |  | IEEE International Roadmap for Devices and Systems  https://www.irds.ieee.org | | |
| 23. |  | Electronika NTB - scientific and technical journal  http://www.electronics.ru | | |
| 24. |  | An international resource for the search and exchange of scientific publications  https://www.researchgate.net | | |

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| 25. |  | iXBT — online publication about computer technology  https://www.ixbt.com | | |
| 26. |  | Imec R&D, nano electronics and digital technologies  https://www.imec.be | | |
| 27. |  | European XFEL  https://www.xfel.eu | | |
| 28. |  | National Research Center «Kurchatov Institute»  http://www.kcsni.nrcki.ru | | |
| 29. |  | Journal "Nano- i mikrosistemnaya tehnika"  http://www.microsystems.ru | | |
| 30. |  | News and analytical portal «Time of Electronics»  http://www.russianelectronics.ru | | |
| 31. |  | Website of the Russian Magnetic Society (MAGO)  http://www.amtc.ru/mago/ | | |
| 32. |  | Web of Science Database  http://www.webofknowledge.com | | |
| 33. |  | Website of the Federal Service for Intellectual Property, Patents and Trademarks  http://www.fips.ru/ | | |
| 34. |  | Information portal for materials science http://www.materialstoday.com | | |
| 35. |  | Website of the PTI Department of Nanoelectronics https://fks.mirea.ru | | |
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| **8.5. METHODOLOGICAL INSTRUCTIONS FOR STUDENTS ON THE INTERNSHIP** | | | | |
| At the first organizational meeting, it is necessary to familiarize students with the content of the work program of the internship, with the order and schedule of the internship.  At the beginning of the internship, at the organizational and preparatory stage, students need to:  - issue an internship assignment;  - be instructed on safety and firefighting equipment;  - get acquainted with the content of the internship work program, the rules and responsibilities of the intern at the enterprise, the structure of the departments (workplaces) of the internship, the working hours of the enterprise;  - get acquainted with the structure of the final report on practice.  During the period of practical training, the student independently studies documentation related to future professional activity, educational, reference, regulatory and scientific and technical literature on the relevant sections of this program. Literature is selected in the university library (including access to EBS), public scientific and technical libraries. Consolidation of practice results is carried out by independent work of students with the recommended literature.  During the internship, the student must solve all the tasks assigned to him and write a report on his activities within the framework of the internship, as well as the work performed (labor actions, labor functions) related to future professional activity of the student. The report should describe all the main stages of the internship in accordance with the task. The report, finalized and signed by the student, is handed over to the head of the practice no later than 3 days before the defense. At the time specified by the head of the practice, the student must appear at the department to defend the report | | | | |
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| **8.6. METHODOLOGICAL RECOMMENDATIONS FOR THE TRAINING OF PERSONS WITH DISABILITIES AND THE DISABLED** | | | | |
| The development of the discipline by students with disabilities can be organized both jointly with other students and in separate groups | | | | |

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| Special conditions are assumed for students with disabilities to receive education.  The teaching staff gets acquainted with the psychological and physiological characteristics of students with disabilities and persons with disabilities, individual rehabilitation programs for the disabled (if available). If necessary, additional teaching support is provided by tutors, psychologists, social workers, trained assistants.  In accordance with the methodological recommendations of the Ministry of Education and Science of the Russian Federation (approved April 8, 2014 N AK-44/05 vn), the course is supposed to use socially active and reflexive teaching methods, technologies of socio-cultural rehabilitation in order to assist in establishing full-fledged interpersonal relationships with other students, creating a comfortable psychological climate in the student group. Selection and development of educational materials are carried out taking into account the provision of material in various forms: auditory, visual, using special technical means and information systems.  Media materials should also be used and adapted taking into account the individual characteristics of the training of persons with disabilities.  The development of the discipline by persons with disabilities is carried out using general and special purpose teaching tools (personal and collective use). Material and technical support provides for the adaptation of classrooms to the needs of persons with disabilities.  The form of certification for students with disabilities is established taking into account individual psychophysical characteristics. For students with HIA, an accessible form of assignment of assessment tools is provided, namely:  - in printed or electronic form (for persons with disorders of the musculoskeletal system);  - in printed or electronic form with enlarged font and contrast (for persons with hearing, speech, vision impairments);  - by the method of reading the task aloud by the assistant (for visually impaired persons).  Students with disabilities have increased time to prepare answers to control questions. For such students, an accessible form of providing answers to tasks is provided, namely:  - written on paper or a set of answers on a computer (for persons with hearing and speech impairments);  - choosing an answer from possible options using the services of an assistant (for people with musculoskeletal disorders);  - oral interview (for persons with visual impairments, musculoskeletal system).  If necessary, for students with disabilities, the procedure for evaluating learning outcomes can be carried out in several stages. |

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| MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION | | | | | | | | | | | | | | | | | | | | | |
| Federal State Budget Educational Institution of Higher Education  «MIREA – Russian Technological University» | | | | | | | | | | | | | | | | | | | | | |
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| **Institute of Physics and Technology** | | | | | | | | | | | | | | | | | | | | | |
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| Working program of the practice | | | | | | | | | | | | | | | | | | | | | |
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| **Industrial practice** | | | | | | | | | | | | | | | | | | | | | |
| **Research work** | | | | | | | | | | | | | | | | | | | | | |
|  | Department leading the training | | | | | |  |  | **Department of Nanoelectronics** | | | | | | | | | | | | |
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|  | Direction of training | | | | | | |  | **11.04.04 Electronics and nanoelectronics** | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Profile | | | | | | |  | **Engineering of modern materials for information technology, renewable energy and sensing** | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |
|  | Qualification | | | | |  |  |  | **Master** | | | | | | | | | | | | |
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|  | Form of education | | | | |  |  |  | **Full-time** | | | | | | | | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Total labor intensity | | | |  |  |  |  | **14 credits** | | | | | | | | | |  |  |  |
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| **Distribution of discipline hours and forms of intermediate certification by semesters** | | | | | | | | | | | | | | | | | | | | | |
| Semester | | Credits | Distribution of hours | | | | | | | | | | | | | | | Forms of intermediate attestation | | |  |
| Total | Lectures | | | | Laboratory work | | | Practical classes | Independent work of students | | Contact work during practice and (or) certification | | | Control of training |  |
| 3 | | 14 | 504 | 0 | | | | 0 | | | 0 | 483,58 | | 2,67 | | | 17,75 | Test with an assessment | | |  |
| including for practicing practical skills | | | | 0 | | | | 0 | | | 0 | 242 | | 0 | | | 0 |  | | |  |
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| The program was made by: |  |  |  |  |
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| *Doctor of Science in Physico-mathematical Sciences, Docent L. Fetisov \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* | | | | |
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| Working program of the practice | | |  |  |
| **Research work** | | | | |
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| it is developed in accordance with FSES HE: | | |  |  |
| Federal State Educational Standard of Higher Education - Magistracy in the Direction of training11.04.04 Electronics and nanoelectronics (order of the Ministry of Science and Higher Education of the Russian Federation from 22.09.2017 г. № 959) | | | | |
|  |  |  |  |  |
| it is based on the curriculum: | | |  |  |
| Direction of training: 11.04.04 Electronics and nanoelectronics  profile: «Engineering of modern materials for information technology, renewable energy and sensing» | | | | |
|  |  |  |  |  |
| The working program was approved at the meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
|  |  |  |  |  |
| Minutes of the department meeting from 02.03.2021 № 3  Head of the Department A. Sigov \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | |

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| **Approval of the WPD for execution in the next academic year** | | | | |
|  |  |  |  |  |
| The working program was revised, discussed and approved for execution in the 2022-2023 academic year at a meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
|  |  |  |  |  |
|  | Minutes of the department meeting from \_\_\_\_\_\_\_\_ 2022. № \_\_  Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
|  |  | | **Signature Printed name** | |
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| **Approval of the WPD for execution in the next academic year** | | | | |
|  |  |  |  |  |
| The working program was revised, discussed and approved for execution in the 2023-2024 academic year at a meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
|  |  |  |  |  |
|  | Minutes of the department meeting from \_\_\_\_\_\_\_\_ 2023. № \_\_  Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
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| **Approval of the WPD for execution in the next academic year** | | | | |
|  |  |  |  |  |
| The working program was revised, discussed and approved for execution in the 2024-2025 academic year at a meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
|  |  |  |  |  |
|  | Minutes of the department meeting from \_\_\_\_\_\_\_\_ 2024. № \_\_  Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
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| **Approval of the WPD for execution in the next academic year** | | | | |
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| The working program was revised, discussed and approved for execution in the 2025-2026 academic year at a meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
|  |  |  |  |  |
|  | Minutes of the department meeting from \_\_\_\_\_\_\_\_ 2025. № \_\_  Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
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| **1. OBJECTIVES OF MASTERING THE PRACTICE** | | | | | |
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| «Research work» aims to form, consolidate and develop Practical classes skills and competencies provided by this work program in accordance with the requirements of FSES HE in the Direction of training 11.04.04 Electronics and nanoelectronics taking into account the specifics of the focus of training – «Engineering of modern materials for information technology, renewable energy and sensing».  Practical training during practice is organized by the direct implementation of certain types of work by students related to future professional activities. | | | | | |
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| **2. THE PLACE OF PRACTICE IN THE STRUCTURE OF THE EDUCATIONAL PROGRAM** | | | | | |
|  | Direction of training: |  | 11.04.04 Electronics and nanoelectronics | | |
|  |
|  | Profile: |  | Engineering of modern materials for information technology, renewable energy and sensing | | |
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|  | Block: |  | Practice | | |
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|  | Part: |  | Part of the curriculum formed by the participants of educational | | |
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|  | Total labor intensity: |  | 14 credits (504 academic hour). | | |
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| **3. KIND, TYPE AND METHOD OF PRACTICE** | | | | | |
|  | Kind of practice: |  | Industrial practice | | |
|  |  |  |
|  | Type of practice: |  | Research work | | |
|  |  |  |
| The method(s) of conducting the practice are determined in accordance with the federal state educational standard. If the standard does not regulate the method of practice, then it is carried out stationary. | | | | | |
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| **4.PLACE AND TIME OF THE PRACTICE** | | | | | |
| «Research work» areas of training 11.04.04 Electronics and nanoelectronics is carried out on the basis of structural divisions of RTU MIREA or in an organization carrying out activities in the profile of the corresponding educational program (hereinafter referred to as a specialized organization), including a structural unit a specialized organization, designed for practical training, on the basis of an agreement concluded between an educational organization and a specialized organization. | | | | | |
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| **5. THE STUDENT’S COMPETENCIES FORMED AS A RESULT OF MASTERING THE PRACTICE** | | | | | |
|  |  |  |  |  |  |
| As a result of mastering the practice, the student must master the following competencies: | | | | | |
| **PC-3** - Capable of determining possible physical implementation options, physical and mathematical models of micro- and nanosystems and using software tools for their design and modeling | | | | | |
| **PC-2** - Capable to apply in-depth knowledge of the structure, physical, physico-chemical properties, the purpose of nanomaterials and nanostructures, and methods of measuring their parameters | | | | | |
| **PC-1** - Capable to apply in-depth knowledge of the structure, physical, physico-chemical properties, the purpose of nanomaterials and nanostructures, and methods of measuring their parameters | | | | | |

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| **THE PLANNED RESULTS OF THE INTERNSHIP CHARACTERIZING THE FORMATION OF COMPETENCIES** | | |
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| **PC-1 : Capable to apply in-depth knowledge of the structure, physical, physico-chemical properties, the purpose of nanomaterials and nanostructures, and methods of measuring their parameters** | | |
|  |  |  |
| **PC-1.1 : Applies in-depth knowledge of the structure, physical, physico-chemical properties, the purpose of nanomaterials and nanostructures, and methods for measuring their parameters in the field of electronics** | | |
| **To know:** | | |
| - structure, physical, physico-chemical properties, purpose of nanomaterials and nanostructures | | |
| **Be able to:** | | |
| - to apply in-depth knowledge about the structure, physical, physico-chemical properties, purpose of nanomaterials and nanostructures in professional activity | | |
| **Possess:** | | |
| - skills in analyzing physical, physico-chemical effects used in modern nanoelectronics and promising for its further development | | |
|  |  |  |
| **PC-1.2 : Analyzes the technological problem at the given norms of technological production, highlighting its basic components and searches for reliable information to solve it for various types of queries** | | |
| **To know:** | | |
| - basic components of the electronic component base production technology | | |
| **Be able to:** | | |
| - analyze technological problems of technological production | | |
| **Possess:** | | |
| - skills in the development of modern technological processes | | |
|  |  |  |
| **PC-2 : Capable to apply in-depth knowledge of the structure, physical, physico-chemical properties, the purpose of nanomaterials and nanostructures, and methods of measuring their parameters** | | |
|  |  |  |
| **PC-2.1 : Participates in the development and implementation of modern technological processes, the development of new equipment, technological equipment, the necessary modes of production of micro- and nanoelectronics products** | | |
| **To know:** | | |
| - the main modern technological processes, the necessary modes of production of micro- and nanoelectronics products | | |
| **Be able to:** | | |
| - introduce the main technological processes of the necessary modes of production of micro- and nanoelectronics products | | |
| **Possess:** | | |
| - skills in the development of modern technological processes of the necessary modes of production of micro- and nanoelectronic products | | |
|  |  |  |
| **PC-2.2 : Evaluates optimal processes and modes in the development of electronics products** | | |
| **To know:** | | |
| - basic electronics elements | | |
| **Be able to:** | | |

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| - analyze processes and modes in the process of developing electronics products | | |
| **Possess:** | | |
| - skills in choosing optimal processes in the development of electronics products | | |
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| **PC-3 : Capable of determining possible physical implementation options, physical and mathematical models of micro- and nanosystems and using software tools for their design and modeling** | | |
|  |  |  |
| **PC-3.1 : Defines possible variants of physical and mathematical models in the field of nanoelectronics** | | |
| **To know:** | | |
| - physical implementation options, physical and mathematical models in the field of nanoelectronics | | |
| **Be able to:** | | |
| - identify possible physical implementation options, physical and mathematical models in the field of nanoelectronics | | |
| **Possess:** | | |
| - skills in analyzing the principles of operation of solid-state electronics elements | | |
|  |  |  |
| **PC-3.2 : Uses software tools for designing and modeling electronics elements** | | |
| **To know:** | | |
| - The main elements of software tools for designing and modeling electronics elements | | |
| **Be able to:** | | |
| - use any software tools for designing and modeling electronics elements | | |
| **Possess:** | | |
| - methods and tools of specialized computer-aided design and modeling of micro- and nanosystems | | |
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| **AS A RESULT OF THE INTERNSHIP , THE STUDENT MUST** | | |
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| **To know:** | | |
| - The main elements of software tools for designing and modeling electronics elements | | |
| - the main modern technological processes, the necessary modes of production of micro- and nanoelectronics products | | |
| - physical implementation options, physical and mathematical models in the field of nanoelectronics | | |
| - basic electronics elements | | |
| - basic components of the electronic component base production technology | | |
| - structure, physical, physico-chemical properties, purpose of nanomaterials and nanostructures | | |
| **Be able to:** | | |
| - to apply in-depth knowledge about the structure, physical, physico-chemical properties, purpose of nanomaterials and nanostructures in professional activity | | |
| - analyze processes and modes in the process of developing electronics products | | |
| - identify possible physical implementation options, physical and mathematical models in the field of nanoelectronics | | |
| - analyze technological problems of technological production | | |
| - use any software tools for designing and modeling electronics elements | | |

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| - introduce the main technological processes of the necessary modes of production of micro- and nanoelectronics products | | | | | |
| **Possess:** | | | | | |
| - methods and tools of specialized computer-aided design and modeling of micro- and nanosystems | | | | | |
| - skills in analyzing the principles of operation of solid-state electronics elements | | | | | |
| - skills in the development of modern technological processes | | | | | |
| - skills in analyzing physical, physico-chemical effects used in modern nanoelectronics and promising for its further development | | | | | |
| - skills in choosing optimal processes in the development of electronics products | | | | | |
| - skills in the development of modern technological processes of the necessary modes of production of micro- and nanoelectronic products | | | | | |
|  |  |  |  |  |  |
| **6. STRUCTURE AND CONTENT OF THE PRACTICE** | | | | | |
|  |  |  |  |  |  |
| During the training sessions, the organization ensures the development of students’ teamwork skills, interpersonal communication, decision-making and leadership qualities. | | | | | |
| **Code** | **Name of sections and topics /type of classes/** | | **Semester** | **Hours** | |
| **1. Organizational and preparatory section** | | | | | |
| **1.1** | **Organizational meeting (CWC).** Acquaintance with the purpose of the practice, the main stages of the practice, the places of the practice, the issuance of assignments for the practice | | 3 | 1,42 | |
| **1.2** | **Occupational Safety and Health Coaching (CWC).** Occupational safety and health briefing | | 3 | 1 | |
| **2. Obtaining practical skills, reviewing materials and forming an internship report** | | | | | |
| **2.1** | **Анализ** **информации** **и** **формирование** **отчёта** **по** **практической** **подготовке** **(IWS).** Collection and systematization of literary data. | | 3 | 60 (including 40 for practicing practical skills) | |
| **2.2** | **Performing tasks aimed at obtaining practical training skills (IWS).** Planning, preparation and execution of a practical assignment | | 3 | 295 (including 152 for practicing practical skills) | |
| **2.3** | **Analysis of information and formation of a practical training report (IWS).** Processing and analysis of the results of the internship Preparation of the practice report. | | 3 | 128,58 (including 50 for practicing practical skills) | |
| **3. Intermediate certification (test with an assessment)** | | | | | |
| **3.1** | **Preparation for the intermediate certification (Test with an assessment).** | | 3 | 17,75 | |
| **3.2** | **Contact work with the teacher during the intermediate certification (CWC).** | | 3 | 0,25 | |
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| **7. EVALUATION MATERIALS** | | | | | |
|  |  |  |  |  |  |
| **7.1. List of competencies** | | | | | |
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| The list of competencies that the program is aimed at mastering «Research work», with an indication of the results of their formation in the process of mastering the educational program, presented in paragraph 3 of this work program | | | | | |
| **7.2. Typical control questions and tasks** | | | | | |

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| Section 1  1.The value of the voltage in the power grid.  2.The problem of grounding devices and installations.  3.The sequence of switching on and off of devices and installations.  4.Handling of chemical reagents.  Section 2  1. Types of scientific publications.  2. Scopus systems, Web of Science, RSCI  3. «Antiplagiat» System  4. Processing of experimental results.  5. Methods for determining the errors of the results of the study.  6. Suggest a methodology for conducting an experiment in the subject area of practical training.  7. Suggest a block diagram of an experimental setup in the subject area of practical training.  8. What duties were performed during the internship? | | | | | |
| **7.3. Fund of evaluation Materials** | | | | | |
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| A complete list of evaluation materials is provided in the Appendix 1. | | | | | |
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| **8. MATERIAL, TECHNICAL, EDUCATIONAL AND METHODOLOGICAL SUPPORT OF THE DISCIPLINE (MODULE)** | | | | | |
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| **8.1. MATERIAL AND TECHNICAL SUPPORT OF THE INTERNSHIP** | | | | | |
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| **Name of premises** | | | | **List of main equipment** | |
| Classroom for lectures and seminars, group and individual consultations, ongoing monitoring and intermediate certification | | | | Multimedia equipment, specialized furniture, sets of demonstration equipment and educational and visual aids that provide thematic illustrations. | |
| A room for independent work of students | | | | Computer equipment with the ability to connect to the Internet and provide access to the electronic information and educational environment of the organization. | |
| Practice bases | | | | Equipment and technical means of training that allow you to perform certain types of work provided for by the assignment for practice. | |
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| **8.2. LIST OF SOFTWARE** | | | | | |
| 1. |  | Microsoft Windows. Contract No.32009183466 from 02.07.2020. | | | |
| 2. |  | Microsoft Office. Contract No.32009183466 from 02.07.2020. | | | |
| 3. |  | Comsol Multiphysics. Sublicense Contract No.31705027784 from 12.05.2017. | | | |
| 4. |  | LabVIEW. Contract No. 0373100029519000161 from 10.12.2019. | | | |
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| **8.3. RECOMMENDED LITERATURE** | | | | | |
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| **8.3.1. Basic literature** | | | | | |

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| 1. |  | Shchuka A. A., Sigov A. S. Elektronika v 4 ch. CHast’ 3. Kvantovaya i opticheskaya elektronika [Electronics resource]:Uchebnik dlya vuzov. - Moskow: Yurajt, 2021. - 117 p – Access mode: https://urait.ru/bcode/470590 | | |
| 2. |  | Gulyaev Yu. V., Ivanov V. I., Luchnikov P. A., Sigov A. S., Surzhikov A. P. Osnovy konstruirovaniya i tekhnologii proizvodstva radioelektronnyh sredstv. Integral’nye skhemy [Electronic resource]:Uchebnik dlya vuzov. - Moskva: Yurajt, 2021. - 460 p– Access mode: https://urait.ru/bcode/470122 | | |
| 3. |  | Kapustin V. I., Sigov A. S. Tekhnologii proizvodstva i kontrol’ kachestva nanomaterialov i nanostruktur [Electronic resource]:uchebnoe posobie. - M.: MIREA, 2017.- – Access mode: http://library.mirea.ru/secret/21022018/1647.iso | | |
| 4. |  | Shchuka A. A., Sigov A. S. Elektronika v 4 ch. CHast’ 2. Mikroelektronika [Electronic resource]: Uchebnik dlya vuzov. - Moskva: YUrajt, 2021. - 326 p– Access mode: https://urait.ru/bcode/470589 | | |
| 5. |  | Abdullaev D. A., Milovanov R. A., Horin I. A., i dr. Issledovanie sistem mnogourovnevoj metallizacii IS na ustanovke Quanta 3D DualBeam [Electronic resource]: metod. ukazaniya. - M.: MIREA, 2018. - – Access mode: http://library.mirea.ru/secret/25052018/1709.iso | | |
| 6. |  | SHCHuka A. A., Sigov A. S. Elektronika v 4 ch. CHast’ 1. Vakuumnaya i plazmennaya elektronika [Electronic resource]:Uchebnik dlya vuzov. - Moskow: YUrajt, 2020. - 172 s – Access mode: https://urait.ru/bcode/451115 | | |
| 7. |  | Shchuka A. A., Sigov A. S. Elektronika v 4 ch. CHast’ 4. Funkcional’naya elektronika [Electronic resource]:Uchebnik dlya vuzov. - Moscow: Yurajt, 2020. - 183 p – Access mode: https://urait.ru/bcode/451677 | | |
| 8. |  | Shchuka A. A., Sigov A. S. Nanoelektronika [Electronics resource]:Uchebnik dlya vuzov. - Moskow: Yurajt, 2021. - 297 p– Access mode: https://urait.ru/bcode/470007 | | |
| 9. |  | Horin I. A. Tekhnologii elektronnoj komponentnoj bazy:uchebnoe posobie. - Saratov: Aj Pi Er Media, 2018. - 277 p. | | |
| 10. |  | Sherstyuk N. E., Gladyshev I. V., Kuznecov V. V. Metodicheskie ukazaniya po vypolneniyu vypusknoj kvalifikacionnoj raboty bakalavra [Electronic resource]:. - M.: RTU MIREA, 2021. - – Access mode: https://library.mirea.ru/secret/11062021/2713.iso | | |
|  |  |  |  |  |
| **8.3.2. Additional literature** | | | | |
| 1. |  | Shchuka A. A., Sigov A. S. Elektronika:Uchebnik dlya akadem. bakalavriata. - M.: Yurajt, 2016. | | |
| 2. |  | Yurasov A. N., Yashin M. M., Levina E. Yu. Izbrannye glavy fiziki kondensirovannogo sostoyaniya:uchebnoe posobie. - M.: RTU MIREA, 2021. - 105 p. | | |
| 3. |  | Gladyshev I. V., Fetisov L. Yu., Yurasov A. N. Matematika v fizicheskih zadachah:uchebnoe posobie. - M.: MIREA, 2020. - 162 p. | | |
| 4. |  | Pevtsov E. F., Krutov V. V. Osnovy avtomatizirovannogo proektirovaniya SVCH ustrojstv i sistem [Electronic resource]:uchebnoe posobie. - M.: RTU MIREA, 2018.- – Access mode: http://library.mirea.ru/secret/06032019/1975.iso | | |
| 5. |  | Demenkova T. A., Pevtsov E. F. Diagnostika cifrovyh ustrojstv [Electronic resource]:uchebnoe posobie. - M.: MGTU MIREA, 2015.- – Access mode: http://library.mirea.ru/secret/e\_1156.iso | | |
| 6. |  | Pevtsov E. F., Tarasov I. E., Minnebaev V. M. Avtomatizirovannoe proektirovanie cifrovyh skhem [Electronic resource]: uchebnoe posobie. - M.: MIREA, 2016.- – Access mode: http://library.mirea.ru/secret/ab/1243.iso | | |
| 7. |  | Pevtsov E. F., Demenkova T. A., Al’-Natah R. I. Osnovy modelirovaniya i proektirovaniya MEMS v SAPR CoventorWare [Electronic resource]:uchebnoe posobie. - M.: MIREA, 2016.- – Access mode: http://library.mirea.ru/secret/ab/1242.iso | | |
| 8. |  | Vorotilov K. A., Muhortov V. M., Sigov A. S. Integrirovannye segnetoelektricheskie ustrojstva:. - M.: Energoatomizdat, 2011. - 174 p. | | |

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| **8.4. RECOMMENDED LIST OF MODERN PROFESSIONAL DATABASES AND INFORMATION REFERENCE SYSTEMS** | | | | |
| 1. |  | Information and legal portal GARANThttp:// www.garant.ru | | |
| 2. |  | Electronic fund of legal and regulatory technical documentation Techexpert http://www.docs.cntd.ru | | |
| 3. |  | NanoNewsNet.ru- non-commercial on-line publication dedicated to the nanoindustry http://www.old.nanonewsnet.ru | | |
| 4. |  | Nanometer - Nanotechnology communityhttp://www.nanometer.ru | | |
| 5. |  | Information portal «Populyarnye nanotehnologii» http://www.popnano.ru | | |
| 6. |  | Russian Foundation for Basic Research https://www.rfbr.ru | | |
| 7. |  | Information portal Russian Science Foundation http://www.rscf.ru | | |
| 8. |  | COMSOL Multiphysics® Software for multiphysical modelinghttps://www.comsol.ru | | |
| 9. |  | Stephen Wolfram: Official Website http://www.stephenwolfram.com | | |
| 10. |  | Wolfram: computing and knowledge, hand to handhttp://www.wolfram.com | | |
| 11. |  | Scientific Electronic Library http://www.elibrary.ru | | |
| 12. |  | Natural Science educational Portal http://www.en.edu.ru | | |
| 13. |  | ХиМик.ru - website about chemistry http://www.xumuk.ru | | |
| 14. |  | Ministry of Science and Higher Education of the Russian Federation  https://www.minobrnauki.gov.ru | | |
| 15. |  | Foundation for the Promotion of Innovation  http://www.fasie.ru | | |
| 16. |  | Information portal of the international citation system “Web of Science”  https://www.apps.webofknowledge.com | | |
| 17. |  | Information portal of the international citation system Scopus  https://www.scopus.com | | |
| 18. |  | The magazine portal of the A.F. Ioffe Institute of Physics and Technology  https://www.journals.ioffe.ru | | |
| 19. |  | Russian Technological Journal  https://www.rtj.mirea.ru | | |
| 20. |  | Information and reference portal of scientific publications of domestic and foreign authors «Google Academy»  https://www.scholar.google.ru | | |
| 21. |  | Simiconductor Industry Association  https://www.semiconductors.org | | |
| 22. |  | IEEE International Roadmap for Devices and Systems  https://www.irds.ieee.org | | |
| 23. |  | Electronika NTB - scientific and technical journal  http://www.electronics.ru | | |
| 24. |  | An international resource for the search and exchange of scientific publications  https://www.researchgate.net | | |
| 25. |  | iXBT — online publication about computer technology  https://www.ixbt.com | | |
| 26. |  | Imec R&D, nano electronics and digital technologies  https://www.imec.be | | |

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| 27. |  | European XFEL  https://www.xfel.eu | | |
| 28. |  | National Research Center «Kurchatov Institute»  http://www.kcsni.nrcki.ru | | |
| 29. |  | Journal «Nano- i mikrosistemnaya tekhnika»  http://www.microsystems.ru | | |
| 30. |  | News and analytical portal «Time of Electronics»  http://www.russianelectronics.ru | | |
| 31. |  | Website of the Russian Magnetic Society (MAGO)  http://www.amtc.ru/mago/ | | |
| 32. |  | Web of Science Database  http://www.webofknowledge.com | | |
| 33. |  | Website of the Federal Service for Intellectual Property, Patents and Trademarks  http://www.fips.ru/ | | |
| 34. |  | Information portal for materials science http://www.materialstoday.com | | |
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| **8.5. METHODOLOGICAL INSTRUCTIONS FOR STUDENTS ON THE INTERNSHIP** | | | | |
| At the first organizational meeting, it is necessary to familiarize students with the content of the work program of the internship, with the order and schedule of the internship.  At the beginning of the internship, at the organizational and preparatory stage, students need to:  - issue an internship assignment;  - be instructed on safety and firefighting equipment;  - get acquainted with the content of the internship work program, the rules and responsibilities of the intern at the enterprise, the structure of the departments (workplaces) of the internship, the working hours of the enterprise;  - get acquainted with the structure of the final report on practice.  During the period of practical training, the student independently studies documentation related to future professional activity, educational, reference, regulatory and scientific and technical literature on the relevant sections of this program. Literature is selected in the university library (including access to EBS), public scientific and technical libraries. Consolidation of practice results is carried out by independent work of students with the recommended literature.  During the internship, the student must solve all the tasks assigned to him and write a report on his activities within the framework of the internship, as well as the work performed (labor actions, labor functions) related to future professional activity of the student. The report should describe all the main stages of the internship in accordance with the task. The report, finalized and signed by the student, is handed over to the head of the practice no later than 3 days before the defense. At the time specified by the head of the practice, the student must appear at the department to defend the report | | | | |
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| **8.6. METHODOLOGICAL RECOMMENDATIONS FOR THE TRAINING OF PERSONS WITH DISABILITIES AND THE DISABLED** | | | | |
| The development of the discipline by students with disabilities can be organized both jointly with other students and in separate groups Special conditions are assumed for students with disabilities to receive education.  The teaching staff gets acquainted with the psychological and physiological characteristics of students with disabilities and persons with disabilities, individual rehabilitation programs for the disabled (if available). | | | | |
| If necessary, additional teaching support is provided by tutors, psychologists, social workers, trained assistants.  In accordance with the methodological recommendations of the Ministry of Education and Science of the Russian Federation (approved April 8, 2014 N AK-44/05 vn), the course is supposed to use socially active and reflexive teaching methods, technologies of socio-cultural rehabilitation in order to assist in establishing full-fledged interpersonal relationships with other students, creating a comfortable psychological climate in the student group. Selection and development of educational materials are carried out taking into account the provision of material in various forms: auditory, visual, using special technical means and information systems.  Media materials should also be used and adapted taking into account the individual characteristics of the training of persons with disabilities.  The development of the discipline by persons with disabilities is carried out using general and special purpose teaching tools (personal and collective use). Material and technical support provides for the adaptation of classrooms to the needs of persons with disabilities.  The form of certification for students with disabilities is established taking into account individual psychophysical characteristics. For students with HIA, an accessible form of assignment of assessment tools is provided, namely:  - in printed or electronic form (for persons with disorders of the musculoskeletal system);  - in printed or electronic form with enlarged font and contrast (for persons with hearing, speech, vision impairments);  - by the method of reading the task aloud by the assistant (for visually impaired persons).  Students with disabilities have increased time to prepare answers to control questions. For such students, an accessible form of providing answers to tasks is provided, namely:  - written on paper or a set of answers on a computer (for persons with hearing and speech impairments);  - choosing an answer from possible options using the services of an assistant (for people with musculoskeletal disorders);  - oral interview (for persons with visual impairments, musculoskeletal system).  If necessary, for students with disabilities, the procedure for evaluating learning outcomes can be carried out in several stages. | | | | |

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| Federal State Budget Educational Institution of Higher Education  «MIREA – Russian Technological University» | | | | | | | | | | | | | | | | | | | | | |
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| **Institute of Physics and Technology** | | | | | | | | | | | | | | | | | | | | | |
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| Working program of the practice | | | | | | | | | | | | | | | | | | | | | |
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| **Industrial practice** | | | | | | | | | | | | | | | | | | | | | |
| **Pre-graduation Practice** | | | | | | | | | | | | | | | | | | | | | |
|  | Department leading the training | | | | | |  |  | **Department of Nanoelectronics** | | | | | | | | | | | | |
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|  | Direction of training | | | | | | |  | **11.04.04 Electronics and nanoelectronics** | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Profile | | | | | | |  | **Engineering of modern materials for information technology, renewable energy and sensing** | | | | | | | | | | | | |
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|  | Qualification | | | | |  |  |  | **Master** | | | | | | | | | | | | |
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|  | Form of education | | | | |  |  |  | **Full-time** | | | | | | | | | |  |  |  |
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|  | Total labor intensity | | | |  |  |  |  | **21 credits** | | | | | | | | | |  |  |  |
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| **Distribution of discipline hours and forms of intermediate certification by semesters** | | | | | | | | | | | | | | | | | | | | | |
| Semester | | Credits | Distribution of hours | | | | | | | | | | | | | | | Forms of intermediate attestation | | |  |
| Total | Lectures | | | | Laboratory work | | | Practical classes | Independent work of students | | Contact work during practice and (or) certification | | | Control of training |  |
| 4 | | 21 | 756 | 0 | | | | 0 | | | 0 | 724,25 | | 14 | | | 17,75 | Test with an assessment | | |  |
| including for practicing practical skills | | | | 0 | | | | 0 | | | 0 | 362 | | 0 | | | 0 |  | | |  |
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| The program was made by: |  |  |  |  |
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| *Doctor of Science in Physico-mathematical Sciences, Docent L. Fetisov \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* | | | | |
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| Working program of the practice | | |  |  |
| **Pre-graduation Practice** | | | | |
|  |  |  |  |  |
| it is developed in accordance with FSES HE: | | |  |  |
| Federal State Educational Standard of Higher Education - Magistracy in the Direction of training11.04.04 Electronics and nanoelectronics (order of the Ministry of Science and Higher Education of the Russian Federation from 22.09.2017 г. № 959) | | | | |
|  |  |  |  |  |
| it is based on the curriculum: | | |  |  |
| Direction of training: 11.04.04 Electronics and nanoelectronics  profile: «Engineering of modern materials for information technology, renewable energy and sensing» | | | | |
|  |  |  |  |  |
| The working program was approved at the meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
|  |  |  |  |  |
| Minutes of the department meeting from 02.03.2021 № 3  Head of the Department A. Sigov \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | |

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| **Approval of the WPD for execution in the next academic year** | | | | |
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| The working program was revised, discussed and approved for execution in the 2022-2023 academic year at a meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
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|  | Minutes of the department meeting from \_\_\_\_\_\_\_\_ 2022. № \_\_  Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
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| **Approval of the WPD for execution in the next academic year** | | | | |
|  |  |  |  |  |
| The working program was revised, discussed and approved for execution in the 2023-2024 academic year at a meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
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|  | Minutes of the department meeting from \_\_\_\_\_\_\_\_ 2023. № \_\_  Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
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| **Approval of the WPD for execution in the next academic year** | | | | |
|  |  |  |  |  |
| The working program was revised, discussed and approved for execution in the 2024-2025 academic year at a meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
|  |  |  |  |  |
|  | Minutes of the department meeting from \_\_\_\_\_\_\_\_ 2024. № \_\_  Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
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| **Approval of the WPD for execution in the next academic year** | | | | |
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| The working program was revised, discussed and approved for execution in the 2025-2026 academic year at a meeting of the department | | | | |
| **Department of Nanoelectronics** | | | | |
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|  | Minutes of the department meeting from \_\_\_\_\_\_\_\_ 2025. № \_\_  Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
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| **1. OBJECTIVES OF MASTERING THE PRACTICE** | | | | | |
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| «Pre-graduation Practice» aims to form, consolidate and develop Practical classes skills and competencies provided by this work program in accordance with the requirements of FSES HE in the Direction of training11.04.04 Electronics and nanoelectronics taking into account the specifics of the focus of training – «Engineering of modern materials for information technology, renewable energy and sensing».  Practical training during practice is organized by the direct implementation of certain types of work by students related to future professional activities. | | | | | |
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| **2. THE PLACE OF PRACTICE IN THE STRUCTURE OF THE EDUCATIONAL PROGRAM** | | | | | |
|  | Direction of training: |  | 11.04.04 Electronics and nanoelectronics | | |
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|  | Profile: |  | Engineering of modern materials for information technology, renewable energy and sensing | | |
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|  | Block: |  | Practice | | |
|  |  |  |
|  | Part: |  | Mandatory part | | |
|  |  |  |
|  | Total labor intensity: |  | 21 credits (756 academic hour). | | |
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|  |  |  |  |  |  |
| **3. KIND, TYPE AND METHOD OF PRACTICE** | | | | | |
|  | Kind of practice: |  | Industrial practice | | |
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|  | Type of practice: |  | Pre-graduation Practice | | |
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| The method(s) of conducting the practice are determined in accordance with the federal state educational standard. If the standard does not regulate the method of practice, then it is carried out stationary. | | | | | |
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| **4.PLACE AND TIME OF THE PRACTICE** | | | | | |
| «Pre-graduation Practice» areas of training 11.04.04 Electronics and nanoelectronics is carried out on the basis of structural divisions of RTU MIREA or in an organization carrying out activities in the profile of the corresponding educational program (hereinafter referred to as a specialized organization), including a structural unit a specialized organization, designed for practical training, on the basis of an agreement concluded between an educational organization and a specialized organization. | | | | | |
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| **5. THE STUDENT’S COMPETENCIES FORMED AS A RESULT OF MASTERING THE PRACTICE** | | | | | |
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| As a result of mastering the practice, the student must master the following competencies: | | | | | |
| **PC-3** - Capable of determining possible physical implementation options, physical and mathematical models of micro- and nanosystems and using software tools for their design and modeling | | | | | |
| **PC-2** - Capable to apply in-depth knowledge of the structure, physical, physico-chemical properties, the purpose of nanomaterials and nanostructures, and methods of measuring their parameters | | | | | |
| **PC-1** - Capable to apply in-depth knowledge of the structure, physical, physico-chemical properties, the purpose of nanomaterials and nanostructures, and methods of measuring their parameters | | | | | |

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| **UC-2** - Capable to manage a project at all stages of its life cycle | | |
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| **THE PLANNED RESULTS OF THE INTERNSHIP CHARACTERIZING THE FORMATION OF COMPETENCIES** | | |
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| **UC-2 : Capable to manage a project at all stages of its life cycle** | | |
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| **UC-2.1 : Forms a project task based on the problem posed and a way to solve it through the implementation of project management** | | |
| **To know:** | | |
| - fundamentals of project management | | |
| **Be able to:** | | |
| - analyze the project task | | |
| **Possess:** | | |
| - skills of solving the problem through the implementation of project management | | |
|  |  |  |
| **UC-2.2 : Develops a project concept within the framework of the designated problem and a project implementation plan, taking into account possible implementation risks and opportunities to eliminate them** | | |
| **To know:** | | |
| - the main risks of the project implementation and the possibility of their elimination | | |
| **Be able to:** | | |
| - analyze the concept of the project within the framework of the designated problem | | |
| **Possess:** | | |
| - skills of developing a project concept taking into account possible risks | | |
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| **PC-1 : Capable to apply in-depth knowledge of the structure, physical, physico-chemical properties, the purpose of nanomaterials and nanostructures, and methods of measuring their parameters** | | |
|  |  |  |
| **PC-1.1 : Applies in-depth knowledge of the structure, physical, physico-chemical properties, the purpose of nanomaterials and nanostructures, and methods for measuring their parameters in the field of electronics** | | |
| **To know:** | | |
| - structure, physical, physico-chemical properties, purpose of nanomaterials and nanostructures | | |
| **Be able to:** | | |
| - to apply in-depth knowledge about the structure, physical, physico-chemical properties, purpose of nanomaterials and nanostructures in professional activity | | |
| **Possess:** | | |
| - skills in analyzing physical, physico-chemical effects used in modern nanoelectronics and promising for its further development | | |
|  |  |  |
| **PC-1.2 : Analyzes the technological problem at the given norms of technological production, highlighting its basic components and searches for reliable information to solve it for various types of queries** | | |
| **To know:** | | |
| - basic norms of technological production | | |
| **Be able to:** | | |
| - analyze the problem taking into account the search for reliable information | | |
| **Possess:** | | |
| - skills of identifying the basic components in a technological problem | | |

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| **PC-2 : Capable to apply in-depth knowledge of the structure, physical, physico-chemical properties, the purpose of nanomaterials and nanostructures, and methods of measuring their parameters** | | |
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| **PC-2.1 : Participates in the development and implementation of modern technological processes, the development of new equipment, technological equipment, the necessary modes of production of micro- and nanoelectronics products** | | |
| **To know:** | | |
| - the main modern technological processes, the necessary modes of production of micro- and nanoelectronics products | | |
| **Be able to:** | | |
| - introduce the main technological processes of the necessary modes of production of micro- and nanoelectronics products | | |
| **Possess:** | | |
| - skills in the development of modern technological processes of the necessary modes of production of micro- and nanoelectronic products | | |
|  |  |  |
| **PC-2.2 : Evaluates optimal processes and modes in the development of electronics products** | | |
| **To know:** | | |
| - basic electronics elements | | |
| **Be able to:** | | |
| - analyze processes and modes in the process of developing electronics products | | |
| **Possess:** | | |
| - skills in choosing optimal processes in the development of electronics products | | |
|  |  |  |
| **PC-3 : Capable of determining possible physical implementation options, physical and mathematical models of micro- and nanosystems and using software tools for their design and modeling** | | |
|  |  |  |
| **PC-3.1 : Defines possible variants of physical and mathematical models in the field of nanoelectronics** | | |
| **To know:** | | |
| - physical implementation options, physical and mathematical models in the field of nanoelectronics | | |
| **Be able to:** | | |
| - identify possible physical implementation options, physical and mathematical models in the field of nanoelectronics | | |
| **Possess:** | | |
| - skills in analyzing the principles of operation of solid-state electronics elements | | |
|  |  |  |
| **PC-3.2 : Uses software tools for designing and modeling electronics elements** | | |
| **To know:** | | |
| - The main elements of software tools for designing and modeling electronics elements | | |
| **Be able to:** | | |
| - use software tools for designing and modeling electronics elements | | |
| **Possess:** | | |
| - methods and tools of specialized computer-aided design and modeling of micro- and nanosystems | | |

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| **AS A RESULT OF THE INTERNSHIP, THE STUDENT MUST** | | | | | |
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| **To know:** | | | | | |
| - basic norms of technological production | | | | | |
| - The main elements of software tools for designing and modeling electronics elements | | | | | |
| - structure, physical, physico-chemical properties, purpose of nanomaterials and nanostructures | | | | | |
| - physical implementation options, physical and mathematical models in the field of nanoelectronics | | | | | |
| - basic electronics elements | | | | | |
| - the main modern technological processes, the necessary modes of production of micro- and nanoelectronics products | | | | | |
| - the main risks of the project implementation and the possibility of their elimination | | | | | |
| - fundamentals of project management | | | | | |
| **Be able to:** | | | | | |
| - introduce the main technological processes of the necessary modes of production of micro- and nanoelectronics products | | | | | |
| - identify possible physical implementation options, physical and mathematical models in the field of nanoelectronics | | | | | |
| - analyze processes and modes in the process of developing electronics products | | | | | |
| - analyze the project task | | | | | |
| - to apply in-depth knowledge about the structure, physical, physico-chemical properties, purpose of nanomaterials and nanostructures in professional activity | | | | | |
| - analyze the concept of the project within the framework of the designated problem | | | | | |
| - analyze the problem taking into account the search for reliable information | | | | | |
| - use software tools for designing and modeling electronics elements | | | | | |
| **Possess:** | | | | | |
| - skills in analyzing the principles of operation of solid-state electronics elements | | | | | |
| - methods and tools of specialized computer-aided design and modeling of micro- and nanosystems | | | | | |
| - skills in analyzing physical, physico-chemical effects used in modern nanoelectronics and promising for its further development | | | | | |
| - skills of developing a project concept taking into account possible risks | | | | | |
| - skills of solving the problem through the implementation of project management | | | | | |
| - skills in choosing optimal processes in the development of electronics products | | | | | |
| - skills in the development of modern technological processes of the necessary modes of production of micro- and nanoelectronic products | | | | | |
| - skills of identifying the basic components in a technological problem | | | | | |
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| **6. STRUCTURE AND CONTENT OF THE PRACTICE** | | | | | |
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| During the training sessions, the organization ensures the development of students’ teamwork skills, interpersonal communication, decision-making and leadership qualities. | | | | | |
| **Code** | **Name of sections and topics /type of classes/** | | **Semester** | **Hours** | |
| **1. Organizational and preparatory section** | | | | | |
| **1.1** | **Organizational meeting (CWC).** Acquaintance with the purpose of the practice, the main stages of the practice, the places of the practice, the issuance of assignments for the practice | | 4 | 2,75 | |

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| **1.2** | **Occupational Safety and Health Coaching (CWC).** Occupational safety and health briefing | | 4 | 1 | |
| **2. Obtaining practical skills, reviewing materials and forming an internship report** | | | | | |
| **2.1** | **Анализ** **информации** **и** **формирование** **отчёта** **по** **практической** **подготовке** **(IWS).** Collection and systematization of literary data. | | 4 | 50 (including 35 for practicing practical skills) | |
| **2.2** | **Performing tasks aimed at obtaining practical training skills (IWS).** Planning, preparation and execution of a practical assignment | | 4 | 400 (including 200 for practicing practical skills) | |
| **2.3** | **Analysis of information and formation of a practical training report (IWS).** Processing and analysis of the results of the internship Preparation of the practice report. | | 4 | 274,25 (including 127 for practicing practical skills) | |
| **2.4** | **Seminar (CWC).** Overview lectures by leading scientists and specialists on modern problems of electronics and microsystem technique | | 4 | 10 | |
| **3. Intermediate certification (test with an assessment)** | | | | | |
| **3.1** | **Preparation for the intermediate certification (Test with an assessment).** | | 4 | 17,75 | |
| **3.2** | **Contact work with the teacher during the intermediate certification (CWC).** | | 4 | 0,25 | |
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| **7. EVALUATION MATERIALS** | | | | | |
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| **7.1. List of competencies** | | | | | |
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| The list of competencies that the program is aimed at mastering «Pre-graduation Practice», with an indication of the results of their formation in the process of mastering the educational program, presented in paragraph 3 of this work program | | | | | |
| **7.2. Typical control questions and tasks** | | | | | |
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| Section 1  1.The value of the voltage in the power grid.  2.The problem of grounding devices and installations.  3.The sequence of switching on and off of devices and installations.  4.Handling of chemical reagents.  Section 2  1. Types of scientific publications.  2. Scopus systems, Web of Science, RSCI  3. «Antiplagiat» System  4. Processing of experimental results.  5. Methods for determining the errors of the results of the study.  6. Suggest a methodology for conducting an experiment in the subject area of practical training.  7. Suggest a block diagram of an experimental setup in the subject area of practical training. | | | | | |

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| 8. What duties were performed during the internship? | | | | | |
| **7.3. Fund of evaluation Materials** | | | | | |
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| A complete list of evaluation materials is provided in the Appendix 1. | | | | | |
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| **8. MATERIAL, TECHNICAL, EDUCATIONAL AND METHODOLOGICAL SUPPORT OF THE DISCIPLINE (MODULE)** | | | | | |
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| **8.1. MATERIAL AND TECHNICAL SUPPORT OF THE INTERNSHIP** | | | | | |
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| **Name of premises** | | | | **List of main equipment** | |
| Classroom for lectures and seminars, group and individual consultations, ongoing monitoring and intermediate certification | | | | Multimedia equipment, specialized furniture, sets of demonstration equipment and educational and visual aids that provide thematic illustrations. | |
| A room for independent work of students | | | | Computer equipment with the ability to connect to the Internet and provide access to the electronic information and educational environment of the organization. | |
| Practice bases | | | | Equipment and technical means of training that allow you to perform certain types of work provided for by the assignment for practice. | |
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| **8.2. LIST OF SOFTWARE** | | | | | |
| 1. |  | Microsoft Windows. Contract No.32009183466 from 02.07.2020. | | | |
| 2. |  | Microsoft Office. Contract No.32009183466 from 02.07.2020. | | | |
| 3. |  | Comsol Multiphysics. Sublicense Contract No.31705027784 from 12.05.2017. | | | |
| 4. |  | LabVIEW. Contract No. 0373100029519000161 from 10.12.2019. | | | |
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| **8.3. RECOMMENDED LITERATURE** | | | | | |
|  |  |  |  |  |  |
| **8.3.1. Basic literature** | | | | | |
| 1. |  | Horin I. A. Tekhnologii elektronnoj komponentnoj bazy:uchebnoe posobie. - Saratov: Aj Pi Er Media, 2018. - 277 p. | | | |
| 2. |  | Shchuka A. A., Sigov A. S. Elektronika v 4 ch. CHast’ 1. Vakuumnaya i plazmennaya elektronika [Electronic resource]: Uchebnik dlya vuzov. - Moskow: Yurajt, 2020. - 172 s – Access mode: https://urait.ru/bcode/451115 | | | |
| 3. |  | Shchuka A. A., Sigov A. S. Elektronika v 4 ch. CHast’ 4. Funkcional’naya elektronika [Electronic resource]:Uchebnik dlya vuzov. - Moscow: Yurajt, 2020. - 183 p – Access mode: https://urait.ru/bcode/451677 | | | |
| 4. |  | Abdullaev D. A., Milovanov R. A., Horin I. A., i dr. Issledovanie sistem mnogourovnevoj metallizacii IS na ustanovke Quanta 3D DualBeam [Electronic resource]: metod. ukazaniya. - M.: MIREA, 2018. - – Access mode: http://library.mirea.ru/secret/25052018/1709.iso | | | |
| 5. |  | Shchuka A. A., Sigov A. S. Elektronika v 4 ch. CHast’ 2. Mikroelektronika [Electronic resource]: Uchebnik dlya vuzov. - Moskva: YUrajt, 2021. - 326 p– Access mode: https://urait.ru/bcode/470589 | | | |
| 6. |  | Gulyaev Yu. V., Ivanov V. I., Luchnikov P. A., Sigov A. S., Surzhikov A. P. Osnovy konstruirovaniya i tekhnologii proizvodstva radioelektronnyh sredstv. Integral’nye skhemy [Electronic resource]:Uchebnik dlya vuzov. - Moskva: Yurajt, 2021. - 460 p– Access mode: https://urait.ru/bcode/470122 | | | |

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| 7. |  | Kapustin V. I., Sigov A. S. Tekhnologii proizvodstva i kontrol’ kachestva nanomaterialov i nanostruktur [Electronic resource]:uchebnoe posobie. - M.: MIREA, 2017.- – Access mode: http://library.mirea.ru/secret/21022018/1647.iso | | |
| 8. |  | Sherstyuk N. E., Gladyshev I. V., Kuznecov V. V. Metodicheskie ukazaniya po vypolneniyu vypusknoj kvalifikacionnoj raboty bakalavra [Electronic resource]:. - M.: RTU MIREA, 2021. - – Access mode: https://library.mirea.ru/secret/11062021/2713.iso | | |
| 9. |  | Shchuka A. A., Sigov A. S. Elektronika v 4 ch. CHast’ 3. Kvantovaya i opticheskaya elektronika [Electronics resource]:Uchebnik dlya vuzov. - Moskow: Yurajt, 2021. - 117 p – Access mode: https://urait.ru/bcode/470590 | | |
| 10. |  | Shchuka A. A., Sigov A. S. Nanoelektronika [Electronics resource]:Uchebnik dlya vuzov. - Moskow: Yurajt, 2021. - 297 p– Access mode: https://urait.ru/bcode/470007 | | |
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| **8.3.2. Additional literature** | | | | |
| 1. |  | Pevtsov E. F., Tarasov I. E., Minnebaev V. M. Avtomatizirovannoe proektirovanie cifrovyh skhem [Electronic resource]: uchebnoe posobie. - M.: MIREA, 2016.- – Access mode: http://library.mirea.ru/secret/ab/1243.iso | | |
| 2. |  | Pevtsov E. F., Demenkova T. A., Al’-Natah R. I. Osnovy modelirovaniya i proektirovaniya MEMS v SAPR CoventorWare [Electronic resource]:uchebnoe posobie. - M.: MIREA, 2016.- – Access mode: http://library.mirea.ru/secret/ab/1242.iso | | |
| 3. |  | Vorotilov K. A., Muhortov V. M., Sigov A. S. Integrirovannye segnetoelektricheskie ustrojstva:. - M.: Energoatomizdat, 2011. - 174 p. | | |
| 4. |  | Demenkova T. A., Pevtsov E. F. Diagnostika cifrovyh ustrojstv [Electronic resource]:uchebnoe posobie. - M.: MGTU MIREA, 2015. – Access mode: http://library.mirea.ru/secret/e\_1156.iso | | |
| 5. |  | Pevtsov E. F., Krutov V. V. Osnovy avtomatizirovannogo proektirovaniya SVCH ustrojstv i sistem [Electronic resource]:uchebnoe posobie. - M.: RTU MIREA, 2018.- – Access mode: http://library.mirea.ru/secret/06032019/1975.iso | | |
| 6. |  | Shchuka A. A., Sigov A. S. Elektronika:Uchebnik dlya akadem. bakalavriata. - M.: Yurajt, 2016. | | |
| 7. |  | Yurasov A. N., Yashin M. M., Levina E. Yu. Izbrannye glavy fiziki kondensirovannogo sostoyaniya:uchebnoe posobie. - M.: RTU MIREA, 2021. - 105 p. | | |
| 8. |  | Gladyshev I. V., Fetisov L. Yu., Yurasov A. N. Matematika v fizicheskih zadachah:uchebnoe posobie. - M.: MIREA, 2020. - 162 p. | | |
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| **8.4. RECOMMENDED LIST OF MODERN PROFESSIONAL DATABASES AND INFORMATION REFERENCE SYSTEMS** | | | | |
| 1. |  | Website of the PTI Department of Nanoelectronics https://fks.mirea.ru | | |
| 2. |  | Information portal for materials science http://www.materialstoday.com | | |
| 3. |  | Website of the Federal Service for Intellectual Property, Patents and Trademarks  http://www.fips.ru/ | | |
| 4. |  | Web of Science Database  http://www.webofknowledge.com | | |
| 5. |  | Website of the Russian Magnetic Society (MAGO)  http://www.amtc.ru/mago/ | | |
| 6. |  | News and analytical portal «Time of Electronics»  http://www.russianelectronics.ru | | |
| 7. |  | Journal «Nano- i mikrosistemnaya tekhnika»  http://www.microsystems.ru | | |
| 8. |  | National Research Center «Kurchatov Institute»  http://www.kcsni.nrcki.ru | | |

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| 9. |  | European XFEL  https://www.xfel.eu | | |
| 10. |  | Imec R&D, nano electronics and digital technologies  https://www.imec.be | | |
| 11. |  | iXBT — online publication about computer technology  https://www.ixbt.com | | |
| 12. |  | An international resource for the search and exchange of scientific publications  https://www.researchgate.net | | |
| 13. |  | Electronika NTB - scientific and technical journal  http://www.electronics.ru | | |
| 14. |  | IEEE International Roadmap for Devices and Systems  https://www.irds.ieee.org | | |
| 15. |  | Simiconductor Industry Association  https://www.semiconductors.org | | |
| 16. |  | Information and reference portal of scientific publications of domestic and foreign authors «Google Academy»  https://www.scholar.google.ru | | |
| 17. |  | Russian Technological Journal  https://www.rtj.mirea.ru | | |
| 18. |  | The magazine portal of the A.F. Ioffe Institute of Physics and Technology  https://www.journals.ioffe.ru | | |
| 19. |  | Information portal of the international citation system Scopus  https://www.scopus.com | | |
| 20. |  | Information portal of the international citation system “Web of Science”  https://www.apps.webofknowledge.com | | |
| 21. |  | Foundation for the Promotion of Innovation  http://www.fasie.ru | | |
| 22. |  | Ministry of Science and Higher Education of the Russian Federation  https://www.minobrnauki.gov.ru | | |
| 23. |  | ХиМик.ru - website about chemistry http://www.xumuk.ru | | |
| 24. |  | Natural Science educational Portal http://www.en.edu.ru | | |
| 25. |  | Scientific Electronic Library http://www.elibrary.ru | | |
| 26. |  | Wolfram: computing and knowledge, hand to handhttp://www.wolfram.com | | |
| 27. |  | Stephen Wolfram: Official Website http://www.stephenwolfram.com | | |
| 28. |  | COMSOL Multiphysics® Software for multiphysical modelinghttps://www.comsol.ru | | |
| 29. |  | Information portal Russian Science Foundation http://www.rscf.ru | | |
| 30. |  | Russian Foundation for Basic Research https://www.rfbr.ru | | |
| 31. |  | Information portal «Populyarnye nanotehnologii» http://www.popnano.ru | | |
| 32. |  | Nanometer - Nanotechnology communityhttp://www.nanometer.ru | | |
| 33. |  | NanoNewsNet.ru- non-commercial on-line publication dedicated to the nanoindustry http://www.old.nanonewsnet.ru | | |
| 34. |  | Electronic fund of legal and regulatory technical documentation Techexpert http://www.docs.cntd.ru | | |
| 35. |  | Information and legal portal GARANThttp:// www.garant.ru | | |
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| **8.5. МЕТОДИЧЕСКИЕ УКАЗАНИЯ ДЛЯ ОБУЧАЮЩИХСЯ ПО ОСВОЕНИЮ**  **ПРАКТИКИ**  At the first organizational meeting, it is necessary to familiarize students with the content of the work program of the internship, with the order and schedule of the internship.  At the beginning of the internship, at the organizational and preparatory stage, students need to:  - issue an internship assignment;  - be instructed on safety and firefighting equipment;  - get acquainted with the content of the internship work program, the rules and responsibilities of the intern at the enterprise, the structure of the departments (workplaces) of the internship, the working hours of the enterprise;  - get acquainted with the structure of the final report on practice.  During the period of practical training, the student independently studies documentation related to future professional activity, educational, reference, regulatory and scientific and technical literature on the relevant sections of this program. Literature is selected in the university library (including access to EBS), public scientific and technical libraries. Consolidation of practice results is carried out by independent work of students with the recommended literature. | | | | |

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| During the internship, the student must solve all the tasks assigned to him and write a report on his activities within the framework of the internship, as well as the work performed (labor actions, labor functions) related to future professional activityью of the student. The report should describe all the main stages of the internship in accordance with the task. The report, finalized and signed by the student, is handed over to the head of the practice no later than 3 days before the defense. At the time specified by the head of the practice, the student must appear at the department to defend the report | | |
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| **8.6. METHODOLOGICAL RECOMMENDATIONS FOR THE TRAINING OF PERSONS WITH DISABILITIES AND THE DISABLED** | | |
| The development of the discipline by students with disabilities can be organized both jointly with other students and in separate groups Special conditions are assumed for students with disabilities to receive education.  The teaching staff gets acquainted with the psychological and physiological characteristics of students with disabilities and persons with disabilities, individual rehabilitation programs for the disabled (if available). If necessary, additional teaching support is provided by tutors, psychologists, social workers, trained assistants.  In accordance with the methodological recommendations of the Ministry of Education and Science of the Russian Federation (approved April 8, 2014 N AK-44/05 vn), the course is supposed to use socially active and reflexive teaching methods, technologies of socio-cultural rehabilitation in order to assist in establishing full-fledged interpersonal relationships with other students, creating a comfortable psychological climate in the student group. Selection and development of educational materials are carried out taking into account the provision of material in various forms: auditory, visual, using special technical means and information systems.  Media materials should also be used and adapted taking into account the individual characteristics of the training of persons with disabilities.  The development of the discipline by persons with disabilities is carried out using general and special purpose teaching tools (personal and collective use). Material and technical support provides for the adaptation of classrooms to the needs of persons with disabilities.  The form of certification for students with disabilities is established taking into account individual psychophysical characteristics. For students with HIA, an accessible form of assignment of assessment tools is provided, namely:  - in printed or electronic form (for persons with disorders of the musculoskeletal system); | | |

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| - in printed or electronic form with enlarged font and contrast (for persons with hearing, speech, vision impairments);  - by the method of reading the task aloud by the assistant (for visually impaired persons).  Students with disabilities have increased time to prepare answers to control questions. For such students, an accessible form of providing answers to tasks is provided, namely:  - written on paper or a set of answers on a computer (for persons with hearing and speech impairments);  - choosing an answer from possible options using the services of an assistant (for people with musculoskeletal disorders);  - oral interview (for persons with visual impairments, musculoskeletal system).  If necessary, for students with disabilities, the procedure for evaluating learning outcomes can be carried out in several stages. |