Ministry of Science and Higher Education
National Research University of Electronic Technology - MIET

APPROVED
Vice-rector for Education
_____ Irina G. Ignatova
«28» декабря 2020.

WORKING PROGRAM OF THE COURSE

«Modern Problems of Electronics»

The direction of training - 11.04.03"Design and electronic devices technology"

The program - "Designing of technical systems by means of 3D-modeling"
The program –"Integrated design of micro-systems by means of Mentor Graphic"

2020

1. LIST OF PLANNED RESULTS OF EDUCATION

The course participates in the formation of the following competencies of educational programs:

Competencies of the educational program	**Competencies /sub competencies, formed in the course**	**Competency / sub-competencyindicators**
PK-3 Able to draw scientifically sound conclusions based on the results of theoretical and experimental studies, give recommendations on improving devices and systems, prepare scientific publications and applications for inventions.	**PK-3. MPE-** Able to draw scientifically substantiated conclusions based on the results of theoretical and experimental research, prepare scientific reports.	**Knowledge** of the principles to obtain and analyze information for experimental research. **Ability** to prepare a presentation on the results of the study. **Proficiency** in preparing scientific presentations based on research results.
UK-4 Able to apply modern communication technologies, including in a foreign language, for academic and profes-sional interaction	**UK-4.** MPE Able to improve and apply modern communication technologies, creativity in Russian and English for academic and professional interaction in the field of intelligent sensory systems	**Knowledge** the rules and patterns of personal and business oral and written communication, modern communication technologies in Russian and English, as well as existing professional communities in the field of intelligent sensory systems for professional interaction. **Ability** to apply in practice communicative technologies, methods and ways of business communication for academic and professional interaction in the field of intelligent sensory systems. **Proficiency** fluent in the method of interpersonal business communication in Russian and English, using professional language forms, means and modern communicative technologies in the field of

		intelligent sensor systems.

Competence РК-3 "Able to draw scientifically substantiated conclusions based on the results of theoretical and experimental research, make recommendations for improving devices and systems, prepare scientific publications and applications for inventions" is formulated on the basis of the professional standard 06.005 "Electronic engineer"

Generalized labor function C. Carrying out research in order to improve radio-electronic means and radio-electronic systems for various purposes.

Labor function C / 01.8. Analysis of a scientific and technical problem based on the selection and study of literary and patent sources

2. PLACE OF THE COURSE IN THE STRUCTURE OF THE EDUCATIONAL PROGRAM

The course is a mandatory part of Block 1 "Courses (modules)" of the educational program. The course is taught in the 2nd year of the 3rd semester (full-time education).

Entrance requirements for discipline:

- knows modern interactive software systems for the execution and editing of texts, images and drawings;

-knows the modern principles of searching, storing, processing, analyzing and presenting information in the required format;

-knows how to solve data processing problems using modern automation tools;

- uses information and communication technologies when searching for the necessary information;

- uses information and communication technologies to prepare documentation.

Course entry requirements include: basic skills in MCET (Materials and components of electronic tools); PFMN (Physical foundations of micro- and nano-electronics); PCPT ECF (Physicochemical principles of Electronic computing facilities technology).

3. VOLUME OF THE COURSE AND TYPES OF EDUCATIONAL WORK

Educational year	Semester	Total workload (credit)	Total workload (hours)	Contact work			Self-study (hours)	Finale evaluation
				Lectures (hours)	Laboratory work (hours)	Seminars (hours)		
2	3	3	108	16	-	16	76	Pass with a Mark

4. COURSE CONTENT

№ and module name of the course	Contact work			Self-study	In-processreviewmethods
	Lectures	Seminars	Laboratory work		
1. Basics of electronic materials science	4	2	-	6	Control test N1 Evaluation of individual homework
2.Properties of materials and their application	6	6	-	26	Control test N2 Control activity 1 Evaluation of individual homework
3. Nanomaterials for Electronics	2	2	-	20	Mid-term control Control activity 2 (using Electronic components)
4. Modern technologies	4	6	-	24	Control activity 3 Knowledge control

4.1. Lectures

Module number	Lecturenumber	Scheduledcontacthours	Summary
1	1	2	General introduction into the course. Fundamentals of electronic materials science. Classification of materials. Rule "composition-structure – properties". Research methods: X-ray and microscopic electron diffraction.
	2	2	Introduction in Electronic theory. Superconductors. Magnetic and electrical domains. Electronic and magnetic characteristics.
2	3	2	Classes of functional materials: metals, alloys. The use of magnetic materials in electronics. Semiconductors: intrinsic and impurity. Semiconductor application in electronics.
	4	2	Polymers and polymer compositions. Thermoplastics and thermo sets. Fillers. Glass and ceramics (oxide, nitrides, carbides, silicide). Polymer

			application in electronics.
	5	2	Composite materials. Matrix and fillers. Construction materials. The use of composite materials in electronics.
3	6	2	Nanomaterials and nanotechnology. Physical and Chemical methods of nanomaterials preparation. Control of properties and their practical application. The main optical and electrical characteristics of nanomaterials.
4	7	2	Modern technologies. Technology of high-precision assembly and high-density installation of electronic devices. Assembly operations with individual and automated implementation
	8	2	Sealing technology: designs and methods for their sealing; selection of materials for case sealing and frameless protection. Automation of technological equipment for the sealing process

4.2. Laboratory works (not applicable)

4.3. Seminars

Module number	Laboratory worknumber	Scheduledcontacthours	Summary
1	1	1	"Composition-structure - property." What is the difference between graphite and diamond? Why aluminum alloys are plastic, and magnesium alloys are brittle. How to remove the porosity of materials. The motivation for choosing a semiconductor material for an electronic device. How to be guided when choosing material for a container with compressed gas
	2	1	Interactive lesson. Watch videos: synthesis of modern materials in the world leading universities. Research by young scientists. *Test 1.* *Homework 1.*
2	3	1	X-ray diffraction methods for determining the crystallinity of materials. Wulf-Bragg formula for X-ray interpretation
	4	1	Methods of electron microscopy. TEM, SEM, AFM, STM. Single crystals, polycrystals and quasi-crystals.
	5	1	Granular structure of metals. Calculation of grain sizes according to ASTM. Test 2
	6	1	Solid solutions. Interstitial and sub-stitutional solid solutions. Examples. Glass in Electronics. Synthesis Methods.
	7	1	Microstructural changes during heating and cooling. Quenching. Thermal shock. Kinetics of heat treatment. TTT Charts. How to conduct annealing for crystalline and amorphous materials. Diffusion transformations.
	8	1	Composite materials in electronics. Cermets. How to control interfacial stresses in composites. Methods of hardening structures. Control activity 1.

3	9	1	Nanotechnology. Synthesis of nanomaterials + technology + application. Feynman's forecast: what has not come true yet. Boundary control. Homework 2
	10	1	NEMS. Application, design features. Control activity 2.
4	11	1	Technology. Processes. Production. Powder metallurgy. Isostatic pressing. Welding. Types of welding and adhesive work (micro-welding and soldering).
	12	1	Methods for producing thin films in vacuum; technological processes for thin-film preparation as a part of micro-assemblies by thermal evaporation in vacuum.
	13	1	Technologies for manufacturing printed circuit boards with high switching density. Technological processes for their manufacture, subtractive technology in the laboratory.
	14	1	Assembly and installation of the functional unit on the printed circuit board (PCB). Technological processes of functional unitassembly, the specifics of automated assembly and installation.
	15	1	Assembly and a functional cell installation on a multilayer ceramic board. Basic technological operations, elemental base and materials.
	16	1	The technological process of adjusting the functional unit. Technological operations of control, testing, identification. Control activity 3

4.4. Students self-study

Module number	**Scheduledwork-load(hours)**	**Type of self-study**
1	2	Preparation to the seminars and lectures
	1	Review of lectures 1-2 and seminars 1-2 for preparation to the test 1
	3	Preparation to the Homework 1
2	10	Review of lectures 3-5 and preparing for test 2
	10	Preparation for the control activity 1
	10	Preparation to the Homework 2
3	10	Preparation for the control activity2 (using Electronic components)
	10	Review of lectureы1-6 and preparingforMidterm control.
4	10	Preparation for the control activity3

4.5. Approximate time of the course works (term project)

not applicable

5. LIST OF LEARNING AND TEACHING SUPPORT MATERIAL FOR SELF-STUDY

Teaching and methodological support for the independent work of students in the EMC of the course (ORIOKS, http://orioks.miet.ru/):
All for lectures on electronic material scan be found on https://www.ece.uvic.ca/~ece220/lecture%20notes/ELEC%20220%20Lecture%201%20of%207.pdf

Module 1 Fundamentals of Electronic Materials Science
Methodological instructions for completing individual homework assignments - "Assignments of 1 module"
1. Nevolin V.K. (Author MIET). Probe nanotechnology in electronics [Electronic resource]: Textbook/ V.K. Nevolin. - 2nd ed. - M.: Technosphere, 2014 .- 176 p. - (World of Electronics). - Access to the electronic version of the book is open at https://e.lanbook.com/ from September 1, 2018 to August 31, 2019 - ISBN 978-5-94836-382-0: 0-00.
2. Electron diffraction analysis of the structure of carbon nanotubes along the direction of their growth [Electronic resource] / R.L. Volkov [et al.]// The surface. X-ray, synchrotron and neutron studies. - M.: Nauka, 2018 .-No. 5. - P. 63-70.
https://elib.miet.ru/MegaPro2/Download/MObject/4558/55970.pdf

Module 2 Properties of materials and their application
Methodical instructions for completing individual homework assignments - "Assignments of 2 modules"
Homework Examples - Ideal Presentations, Sample Essays;
Presentations by topic: writing essays and text accompaniment to the report, rules for writing essays on problems in electronics.
1.Issues in Science and Technology [Text]: Textbook for the discipline "Foreign language" for undergraduates in technical areas of training / M.G. Evdokimova, E.G. Gushchina, M.V. Yushina; Ministry of Education and Science of the Russian Federation, National Research University "MIET"; Ed. M.G. Evdokimova. - M.: MIET, 2016 .- 84 p. - There is an electronic version.

Module 3. Nanomaterials for Electronics
Methodical instructions for completing individual homework assignments - "Assignments of 3 modules"
Methodological instructions for the implementation of the Presentation on the topics of the Graduation Qualification Work
1. Nanotechnology in electronics [Text]. Vol. 3 / Ed. Yu.A. Chaplygin. - M.: Technosphere, 2015 .-480 p.
2. Applications of Nanomaterials in Sensors and Diagnostics [Electronic resource] /Ed. AdisornTuantranont: Springer, 2013. - (Volume 14. Springer Series on Chemical Sensors and Biosensors). - URL: http://link.springer.com/book/10.1007/978-3-642-36025-1 - 09/27/2018. - ISBN 978-3-642-36024-4 (Print); 978-3-642-36025-1 (Online).

Module 4 “Modern Technologies”

Methodical instructions for completing individual homework assignments - "Assignments of 4 modules"
Methodical instructions for performing testing at the Rubezhny control.
1.Scientific-practical conference-competition in English on the theme "Crucial issues of science and technology". (Zelenograd, November 29, 2017) [Text]: Conference proceedings / Ministry of Education and Science of the Russian Federation, MIET National Research University. - M.: MIET, 2017 .-36 p.
2.Goodilin D. Minimal Fab - a look into the future of the semiconductor industry [Text] // NANOINDUSTRY. - M.: Technosphere, 2017. - No. 5. - P. 14-18.
3.Gottstein G. Physical and chemical foundations of materials science [Electronic resource]: Textbook/ G. Gottstein; translation by K.N. Zolotova, D.O. Charkin; Ed. V.P. Zlomanova. - 3rd ed., Electronic. - M.: Binom. Knowledge Laboratory, 2017 .- 403 p. Link to the resource: https://e.lanbook.com/book/94155#

Links to the electronic component for the implementation of the self-study work

http://www.robotshop.com/blog/en/how-to-make-a-robot-lesson-1-3707,
https://youtu.be/ZL8h_cbVCzU
https://youtu.be/N5E2TtoXF8Y, https://www.youtube.com/watch?v=oChEkTOdwAM
http://vitbe.ru/watch/LDC5t2SaqJ8
https://3dprintingindustry.com/news/weekly-education-series-make-3d-printer-wireless-78383/
3D Printing Video Blog2 – Make your 3D printer wireless with Octoprint and raspberry Pi.
https://www.youtube.com/watch?v=anIy6eb1fW0
https://www.youtube.com/watch?v=id90y5fkirE
Electronic resource
http://kibevs.tusur.ru/sites/default/files/upload/manuals/Torgonski_PC/Torgonski_PCPU_p2.pdf
http://youtube.com/watch?v=YY_g-6HRl2A&feature=player_embedded
,http://youtube.com/watch?v=naijPsq9oR4
1. https://www.youtube.com/watch?v=F5w4AxAcJ-A

6. LIST OF COURSE LITERATURE

Literature

1. Korobova N. Materials for Electronics: Textbook / N. Korobova, S. Timoshenkov; Ministry of Education and Science of the Russian Federation National Research University "MIET". M.: MIET: MAXSPACE, 2015 .- 474 p.
2. Nalewajski R.F. Perspectives in Electronic Structure Theory / R.F. Nalewajski. - : Springer, 2012. - URL :http://link.springer.com/book/10.1007%2F978-3-642-20180-6 (accessed date: 22.06.2020) . - ISBN 978-3-642-20179-0 (Print); 978-3-642-20180-6 (Online).
3. Applications of Nanomaterials in Sensors and Diagnostics / AdisornTuantranont, ed. - : Springer, 2013. - (Volume 14. Springer Series on Chemical Sensors and Biosensors). - URL : http://link.springer.com/book/10.1007/978-3-642-36025-1 (accessed date:: 29.04.2020). - ISBN 978-3-642-36024-4 (Print); 978-3-642-36025-1 (Online).
4. Device Applications of Silicon Nanocrystals and Nanostructures / Koshida N., ed. - : Springer, 2009. - (Nanostructure Science and Technology). - URL : http://link.springer.com/book/10.1007/978-0-387-78689-6 (accessed date: 27.09.2020). -

ISBN 978-0-387-78688-9 (Print); 978-0-387-78689-6 (Online).

Periodical publications

1. INTERNATIONAL JOURNAL OF INTELLIGENT ROBOTICS AND APPLICATIONS - Springer, 2017URL: https://link.springer.com/journal/41315(accessed date: 05/19/2019)
2. NANOTECHNOLOGIES IN RUSSIA. -: Springer. - It comes out 6 times a year. The site contains the full texts of journal articles since 2008- . - URL: http://link.springer.com/journal/12201(accessed date: 19.05.2020)

7. LIST OF INTERNET SOURCES

1. SCOPUS: Bibliographic and abstract database of scientific periodicals:website. –URL: www.scopus.com. (accessed date: 19.05.2020).
2. LAN: Electronic Library System. - St. Petersburg, 2011. - URL: https://e.lanbook.com. (accessed date: 19.05.2020).
3. eLIBRARY.RU: scientific electronic library. - Moscow, 2000. - URL: https://elibrary.ru. (accessed date: 19.05.2020).

8. LIST OF INFORMATION TECHNOLOGIES

In the course of the implementation of training, blended learning is used, based on the integration of traditional and e-learning technologies, part of the training sessions are held using the interaction of students and a teacher in an electronic educational environment.
In the learning process, during classes and for independent work, all marks will be periodically transferred to the ORIOKS Corporate Information Technology Platform (http://orioks.miet.ru).
For methodological support and implementation of all tasks of the IWS, ORIOKS contains presentations, videos, examples of tasks performed.
The discipline uses distance educational technologies using Skype for online classes and online teamwork. The discipline can be fully implemented in a distance format.
Feedback services are used to interact with the teacher: teacher's e-mail, Skype.
The development of the educational program is provided by the resources of the ORIOKS Corporate Information Technology Platform http://orioks.miet.ru.

9. MATERIAL AND TECHNICAL SUPPORT OF THE COURSE

Name of special room(s) and premises for independent work	**Equipment provided in the specified room(s)**	**List ofavailabesoftware**
Classroom(s)	multimedia equipment	OC Microsoft Windows Microsoft Office Acrobat Reader DC Browser

Room(s) for independent work of students	Computer equipment with the ability to connect to the Internet and provide access to ORIOKS	OC Microsoft Windows Microsoft Office Acrobat Reader DC Browser

10. EVALUATION COMPETENCY FRAMEWORK (ECF) FOR VERIFICATION OF FORMED COMPETENCES

1. ECF according to the competence / sub-competence of UK-4 MPE "Able to apply modern communication technologies in a foreign language for professional interaction".
2. ECF according to competence / sub-competence of PK-3 MPE – "Able to draw scientifically sound conclusions based on the results of theoretical and experimental studies, prepare scientific presentations".
Funds for appraisal funds are presented in separate documents and placed as part of the CMD of the discipline of the electronic information educational environment ORIOKS // URL: http://orioks.miet.ru/.

11. METHODICAL INSTRUCTIONS FOR STUDENTS

11.1. Features of the learning process organization

High-quality student education is active work in lectures, mobilization of attention to the presented material, consistent assimilation of the material, the ability to write down the main points, categories, generalizations, conclusions, own thoughts, comments, questions. Lectures are held in a multimedia audience in the form of presentations. Lecture notes in ppt format in electronic form are available for students, you can continue to work with them at home, supplementing with material from the textbook. The maximum efficiency from working at lectures is achieved with preliminary preparation for it - the student should familiarize himself with the upcoming topic of the lecture and its main points proposed by the teacher or found in the recommended basic literature, prepare questions for the lecturer. In the process of modules studying, students participate in lectures, press conferences, lectures, discussions on the course topics.Tasks for self-study work of students (SWS) should deepen and expand knowledge of the discipline. The SWS is not a simple continuation of academic work. The material offered to students for the implementation of the SWS is available and corresponds to the level of student development. Work on the task is carried out independently in the audience and at home. Each stage is checked and evaluated by the teacher, difficult moments are worked out, and recommendations are issued.

The electronic components proposed for the SWS implementation - video clips will give elementary tips on the use of modern information technologies, and will help to publicly speak out with the self-made design of the electronic device. The presentation of the construction is accompanied by an explanation of the selected technical solution, answers to questions from the audience.15 hours are allocated for the SWS implementation using electronic components. Since

the professional discipline is taught in English, consulting work during which a dictionary of new terms on the topic, questions for testing knowledge, questions and tasks leading to the need to study some additional information about the operating principle of the manufactured device, the element base and functional units of the device is very important.

When evaluating the result, it is taken into account: 1) the degree of the student's independent activity — the use of research methods, the hypothesis of the solution; how the discussion of experimental design methods took place, 2) the way of final results designing - presentation, video clip, report. Presentation of the SWS results is held in a practical lesson (seminar), which can be organized as a Round table or Sectional session at a scientific and practical conference. Commission of students is formed; mandatory criteria for assessment are set out to evaluate the SWS results. You can add new ones at the request of students. Evaluation criteria such as a systematic approach, novelty, completeness of presentation, level of presentation culture, professional skill and artistry, creativity and brightness of the presentation, etc. are possible.A big positive point in the free exchange of views is that students learn to give evidence-based explanations for the made statements and gain the skills to listen carefully and actively participate in the discussion. Discipline can change its content at each implementation of the training profile, but the federal state educational standards, as well as the individual psychological characteristics of students, that is, the level of their knowledge in this field and the requests of each student learning group, will always serve as the basis for selecting the content of independent work.

11.2 Monitoring and evaluation system

Cumulative point system is used to assess student performance in the discipline. The implementation of each semester control eventin the amount of 100 points is evaluated. The total score for the subject is set. The structure and deadlines for control measures, as well as a detailed scoring scheme are presented during first lesson (see also the performance journal on the ORIOKS platform http://www.rpk.miet.ru). The following abbreviations are used: T –test; CA - control activity, IH - individual homework, MC - midterm control; D/A - diligence and activity of students in the study of discipline.

When scoring points, the following rules apply:

1. For each control event, a certain countable number of points have been established, corresponding to the mastery of discipline at a basic level.
2. Failure to appear for the control work and failure of the controlactivity 1-3 to be checked within the established deadlines is equivalent to the unsuccessful passing of these control measures.
3. If the student has not scored a sufficient number of points for the control measure, he must redo it.
4. If the score received for timely completion of the controlactivity 1-3 does not suit the student, he can correct it within a week and pass it again for verification (and get an estimate up to the maximum).

The amount of additional points for all individual assignments cannot exceed the sum of mandatory points received by the student in the semester. The structure and schedule of the

follow-up activities are shown in the table below (see also the progress report on the ORIOKS, http://orioks.miet.ru/).

When setting the final grade, the scale in the table is used:

Total number of points	Mark
Less than 50	2
50 – 69	3
70 – 85	4
86 – 100	5

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Working program «Modern Problems of Electronics » on direction 11.04.03 "Design and electronic devices technology", program - "Designing of technical systems by means of 3D-modeling", program –"Integrated design of micro-systems by means of Mentor Graphic", developed by the «Nano - Microsystems technique» (NMST) institute and approved on a institute meeting at 24.12.2020, record № 6.

Head of the NMST institute _____/ S.P. Timoshenkov/

APPROVAL SHEET

The program is approved with the Coordination and Monitoring Center (CMC) of the main educational programs
Head of CMC _____/I.M. Nikulina/

The program is approved with the MIET library
Director of the Library _____/T.P. Filippova/