SUAI State University of Aerospace Instrumentation

“Embedded systems” masters’ program

Module Handbook

Department of Aerospace Computer and Software systems

Russia, Saint-Petersburg,
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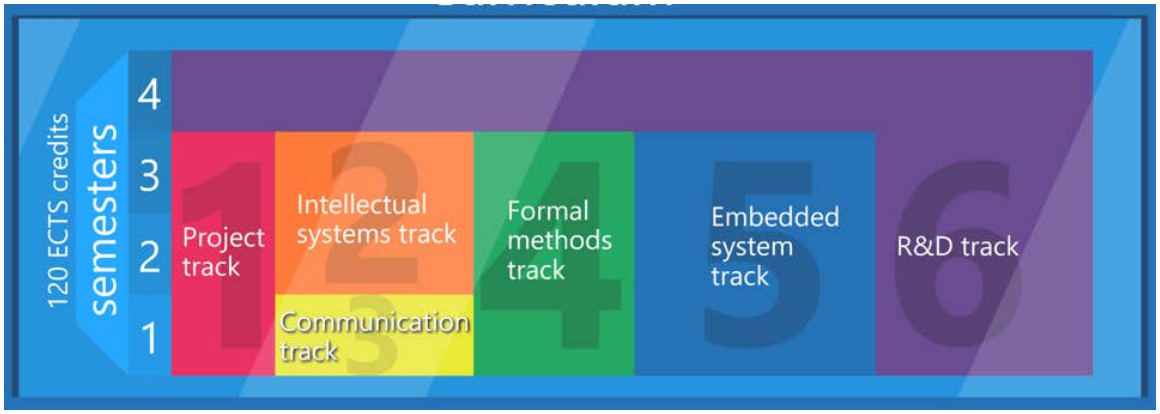
Program description

This master program is designed and launched by the Department of Aerospace Computer and Software Systems in close collaboration with the Institute of High-Performance Computer and Network Technologies (IHPCNT) in the St. Petersburg State University of Aerospace Instrumentation (SUAI, Russia). IHPCNT serves as a scientific and technical base for training of masters and postgraduates in SUAI. The Institute has a great competence in aerospace industry and Embedded Software Design for various domains (image processing, microcontrollers, etc.)

The field “Embedded systems” allows students getting an occupation associated with state-of-the-art technologies, being demanded experts in the market of this area and developing their research skills obtained in the process of study.



Curriculum consists of the six main tracks producing different learning outcomes and students’ competences:

1. Project track is related to the project management and business.
2. Communication track gives international language communication skills and philosophy of engineering.
3. Intellectual systems track provides students with knowledge on modern information processing methods and neural networks’ concepts.
4. Formal methods track prepares students for the research and gives mathematical background that was missing during the studying in bachelor.
5. Embedded systems track is the main track for embedded systems design, development and implementation competences.
6. R&D track stands for the work in multidisciplinary projects during the studying, including masters’ thesis work and scientific seminars.

CDIO educational standards are used as the framework for Embedded system masters’ program. CDIO is an educational framework that stresses engineering fundamentals set in the context of conceiving, designing, implementing and operating real systems and products.

Students can choose between two versions of the program: Russian and English. Some modules in these programs are differ, and the studying language is also different.

Embedded systems (in English)

4	Teaching practice *(credit)* *6 ECTS*	Industrial practice *(credit)* *6 ECTS*	Final exams *(exam)* *9 ECTS*	***Master's Thesis + R&D project*** *(defense)* *6 ECTS*						30 credits
3	Artificial neural networks *(exam)* *4 ECTS*	*Systems for digital image processing* *(exam)* *5 ECTS*	Entrepreneurship basics *(credit)* *5 ECTS*	Information safety and security *(exam)* *6 ECTS*	Onboard computing networks *(credit)* *3 ECTS*	*Computer networks and telecom.* *(exam)* *4 credits*		Scientific seminars *(credit)* *1 ECTS*	**Main R&D project** *(credit)* *2 ECTS*	30 credits
2	Intellectual systems (exam) *6 ECTS*	Systems for digital signal processing *(exam)* *3 ECTS*	Optimization methods *(credit)* *5 ECTS*	Transmission of discrete messages *(credit)* *2 ECTS*	Systems- and Networks-on-Chip *(credit)* *2* ECTS	Architecture of parallel systems *(exam)* *6 ECTS*	Systems modeling *(credit)* *2 ECTS*	Scientific seminars *(credit)* *1 ECTS*	*3 ECTS*	30 credits
1	International language *(exam)* *6 ECTS*	Methodology of scientific cognition *(credit)* *5 ECTS*	Project mng. for inf. Systems (exam) *6 ECTS*	Math. methods for scientific research (credit) *2 ECTS*	Embedded Systems Design in VLSI (exam) *3 ECTS*	Parallel programming *(credit)* *3 ECTS*		Scientific seminars *(credit)* *1 ECTS*	**Introductory R&D project** *(credit, defense)* *4 ECTS*	30 credits

Embedded systems (in Russian)

4	Teaching practice *(credit)* *6 ECTS*	Industrial practice *(credit)* *6 ECTS*	Final exams *(exam)* *9 ECTS*	***Master's Thesis*** *(defense)* *6 ECTS*						30 credits
3	Artificial neural networks *(exam)* *4 ECTS*	*Systems for digital image processing* *(exam)* *5 ECTS*	Entrepreneurship basics *(credit)* *5 ECTS*	Information safety and security *(exam)* *6 ECTS*	Onboard computing networks *(credit)* *3 ECTS*	*Computer networks and telecom.* *(exam)* *4 credits*		Scientific seminars *(credit)* *1 ECTS*	**R&D work** *(credit)* *2 ECTS*	30 credits
2	Intellectual systems (exam) *6 ECTS*	Systems for digital signal processing *(exam)* *3 ECTS*	Optimization methods *(credit)* *5 ECTS*	Transmission of discrete messages *(credit)* *2 ECTS*	Systems- and Networks-on-Chip *(credit)* *2* ECTS	Architecture of parallel systems *(exam)* *6 ECTS*	Specification and modelling languages *(credit)* *2 ECTS*	Scientific seminars *(credit)* *1 ECTS*	*3 ECTS*	30 credits
1	International language *(exam)* *6 ECTS*	Methodology of scientific cognition *(credit)* *5 ECTS*	Project mng. for inf. Systems (exam) *6 ECTS*	Embedded systems interfaces (credit) 2 ECTS	Embedded Systems Design in VLSI (exam) *3 ECTS*	Computing networks *(credit)* *3 ECTS*		Scientific seminars *(credit)* *1 ECTS*	*4 ECTS*	30 credits

English program subjects

Semester #1

- Mathematical methods for scientific research
- Methodology of scientific cognition
- Project management for information systems
- Embedded systems Design in VLSI
- Parallel programming
- Foreign language
- Scientific seminars

+ Introductory R&D project

Semester #2

- Systems for digital signal processing
- Systems modeling
- Intellectual systems
- Methods for transmission of discrete messages
- Architecture of parallel computing systems
- Systems- and Networks-on-Chip
- Optimization methods
- Scientific seminars

+ Main R&D project

Semester #3

- Entrepreneurship basics
- Computer networks and telecommunications
- Information safety and security
- Systems for digital image processing
- On-board computing networks
- Artificial neural networks
- Scientific seminars

+ Main R&D project

Semester #4

- Maters thesis (based on R&D project)
- Scientific seminars
- Teaching practice

+ Finishing R&D project

Russian program subjects

Semester #1

- Embedded systems interfaces
- Methodology of scientific cognition
- Project management for information systems
- Embedded systems Design in VLSI
- Computing networks
- Foreign language
- Scientific seminars

+ R&D practice

Semester #2

- Systems for digital signal processing
- Specification and modeling languages
- Intellectual systems
- Methods for transmission of discrete messages
- Architecture of parallel computing systems
- Systems- and Networks-on-Chip
- Optimization methods
- Scientific seminars

+ R&D practice

Semester #3

- Entrepreneurship basics
- Computer networks and telecommunications
- Information safety and security
- Systems for digital image processing
- On-board computing networks
- Artificial neural networks
- Scientific seminars

+ R&D practice

Semester #4

- Maters thesis
- Scientific seminars
- Teaching practice

+ R&D practice

Modules description

R&D project

Scientific supervisor:	Any person from the department staff; depends on the project area
Module code:	Б.2.Б.1, base module
Lesson types:	R&D project teamwork
Description:	Participating in an R&D Project gives the ability for students to get the real design-implement experience. Students work on tasks that could be of an interest of industrial partners. These projects last for the whole semester, give a deep knowledge in the field, and could become a base for the master's thesis for each student in the project. Projects are implemented under the control and supervising of the specialists and professors from our department. Results would be used in real SUAI R&D projects.
Semester, duration:	S 1-4, 255 hours.
Knowledge evaluation:	Milestone presentations and project defense.
Documentation:	Lectures in electronic form, useful literature and technical documentation.
Language:	English or Russian.
Competences:	• Critical analysis of problem situations based on a systematic approach, development of an action strategy; • Determination and implementation of priorities of one's own activities and ways to improve them based on self-assessment; • Development and modernization of software and hardware for information and automated systems; • Development of a methodology for performing analytical work; • Implementation of the integration of the developed system software; • Synthesis of logic circuits based on the selected technological library based on the specified time and physical constraints using computer-aided design tools.
Recommended literature:	Depending on a project area

Scientific seminars

Scientific supervisor:	Vladimir Ivanov, PhD, Associate professor;
Module code:	Б.2.Б.9, base module
Lesson types:	Seminar
Description:	Scientific seminars are a part of preparation for a Masters defense. During the discussions students are step-by-step presenting their work and research results. So it is useful to get the competence of presentation and proving of your opinion. It is also good to work on communication skills.
Semester, duration:	S 1-3, 102 hours.
Knowledge evaluation:	Seminars and discussions.
Documentation:	Presentations.
Language:	English or Russian.
Competences:	• Independent acquisition, development and application of mathematical, natural science, socio-economic and professional knowledge in order to solve non-standard problems, including those in a new or unfamiliar environment and in an interdisciplinary context • Analysis of professional information, identification of its essence, structuring and presentation as analytical reviews with reasoned conclusions and recommendations • Practical application of new scientific principles and research methods • Development of components of software and hardware systems for information processing and computer-aided design • Adaptation of foreign information processing and computer-aided design complexes to the needs of domestic enterprises.
Recommended literature:	Depending on a project area

Embedded systems Design in VLSI

Scientific supervisor:	Eugeniy Yablokov, PhD, Associate professor;
Module code:	Б.2.В.1, elective module
Lesson types:	Lectures, practical works, individual work
Description:	This module gives a deep knowledge of using of VHDL for VLSI design. Module includes the description of VHDL language, its main concepts, operators, etc. Also during the lectures, students get the knowledge how to use VHDL for design, some technology features, and process of implementation and VLSI synthesis. During the practice students can write the VHDL description of the scheme and practically try to make synthesis with the professional Cadence software.
Semester, duration:	S1, 108 hours.
Knowledge evaluation:	Discussions with a tutor, final exam.
Documentation:	Lectures in electronic form, useful literature.
Language:	English or Russian.
Competences:	• Development of methods for performing analytical work • Integration of the developed system software • Carrying out research and development work.
Recommended literature:	• P. N. Bibilo. VHDL language basics. - M. : Solon-P, 2000. - 200 p. • John Catsoulis. Designing Embedded Hardware. O'Reilly Media, Inc., 2005, - 398 p. • Suvorova E.A., Sheynin Yu.E. Digital systems design using VHDL. БХВ-Петербург, 2003, - 576 p. • Daniel D. Gajski, Samar Abdi, Andreas Gerstlauer, Gunar Schirner. Embedded System Design: Modeling, Synthesis and Verification. Springer Science & Business Media, 2009, - 352 p.

Foreign language

Scientific supervisor:	Elena Belitch (International department)
Module code:	Б.1.Б.1, base module
Lesson types:	Lectures, individual work
Description:	Studying the foreign (Russian) language helps students to live in Russia and communicate with people, learn some new cultural aspects and feel more comfortable. International language studying includes basic knowledge like the alphabet, basic phrases, hearing and pronouncing skills with reference to a new language and speech material, spelling skills, typical grammatical forms and structures, general and communicative competences (reading, speaking, writing, translation)
Semester, duration:	S1, 216 hours.
Knowledge evaluation:	Final exam
Documentation:	Lectures in electronic form, useful literature.
Language:	Mixed English and Russian.
Competences:	• Application of modern communication technologies, also in a foreign language, for academic and professional interaction • Analysis and consideration of cultural diversity in the process of intercultural interaction.
Recommended literature:	• Rubtsova, M. G. Chteniye i perevod angliyskoy nauchnoy i tekhnicheskoy literatury: leksiko- grammaticheskiy spravochnik/ M. G. Rubtsova. - 2-ye izd., ispr. i dop.. - M.: AST; M.: Astrel', 2014. – 384 s. • Frol'kis, E. D. Uchis' izvlekat' informatsiyu pri chtenii = Learning to read for information: uchebnoye posobiye/ E.D.Frol'kis; Red. Ye.O.Kazey; RAN. Kaf.inostr. yaz. - M.:Akademicheskiy proyekt,2010. - 95 s. • Delovoye obshcheniye na inostrannom yazyke: Metodika obucheniya / N.M. Gromova. - M.:Magistr: INFRA-M,2010. - 286 s.: 60x90 1/16.

Parallel programming

Scientific supervisor:	Alexey Syschikov, Senior lecturer;
Module code:	Б.1.В.ДВ.2, elective module
Lesson types:	Lectures, practical work, individual work
Description:	This module gives the information on programs parallelization concepts. Module overviews different classes of parallel computing systems, principals of the synchronous and asynchronous message exchange. After that MPI language is being described including general concepts, application, execution of programs, synchronization, etc. In addition, the module overviews the other parallel programming language OpenMP, its application, directives and other concepts. This knowledge is useful for students because programs parallelization for the embedded systems becomes very popular and important in modern engineering practice.
Semester, duration:	S1, 108 hours.
Knowledge evaluation:	Pass-fail test
Documentation:	Lectures in electronic form, useful literature.
Language:	English.
Competences:	• Development of a methodology for performing analytical work • Integration of the developed system software.
Recommended literature:	• Levin M. P. Parallel programming with OpenMP: user guide / M.: BINOM. 2008. - 120 P. • Robachevskiy A., S. Nemnugin, O. Stesik. UNIX Operation system: user guide - 2-nd ed. - SPb.: BHV, 2008. - 635 p. • Gordeev A. V. Operation systems - 2-nd ed. - SPb.: PITER, 2006. - 415 p. • Deytel H. M., П. Leytel J., Chofnes D. R. Operation systems. Basics and principals. -3-rd ed. -M.: Binom, 2006.-1024 p.

Computing networks

Scientific supervisor:	Sergey Gorbachev, PhD, associate professor;
Module code:	Б.1.В.ДВ.2, elective module
Lesson types:	Lectures, laboratory work, consultation, individual work
Description:	The content of the module covers a range of issues related to the organization of various types of existing network technologies used to build computer networks, as well as knowledge and skills of theoretical research of computer networks and verification of network software (analytical methods for studying network characteristics, methods for routing high-speed supernets and building them topologies, algorithms for managing network traffic based on quality of service parameters).
Semester, duration:	S1, 108 hours.
Knowledge evaluation:	Final exam
Documentation:	Lectures in electronic form, useful literature.
Language:	Russian.
Competences:	• Development of a methodology for performing analytical work • Integration of the developed system software.
Recommended literature:	• Davis D., Barber D., Price W., Solomonides S. Computing networks and network protocols. – M.: Mir, 1982. • A. Tannenbaum Computer networks- 3-rd ed. - M.: Piter, 2002. - 846 p. • Gorbachev S.V., Gorunov P.V., Sheynin Yu.E. ATM technology in high-speed computing networks. - Spb: SUAI, 2000. – 203 p.

Project management for information systems

Scientific supervisor:	Alexey Rabin, PhD, Associate professor;
Module code:	Б.1.Б.5, base module
Lesson types:	Lectures, laboratory work, individual work
Description:	Current module gives main concepts of the software design, implementation and integration analysis, it is closely related to software project management. It overviews metrology for software project, standardization and certification, risk management. In addition, the module takes into account verification, validation of software and testing methods.
Semester, duration:	S1, 216 hours.
Knowledge evaluation:	Final exam
Documentation:	Lectures in electronic form, useful literature.
Language:	English or Russian.
Competences:	• Critical analysis of problem situations based on a systematic approach, development of an action strategy • Project management at all stages of its life cycle • Organization and management of team work, developing a team strategy to achieve the goal • Analysis of professional information, identification of its essence, structuring and presentation as analytical reviews with reasoned conclusions and recommendations • Effective management of software development and projects.
Recommended literature:	• What Every Engineer Should Know about Project Management / Ruskin A.M., Estes W.E. — New York: Marcel Dekker, Inc., 1994 • Managing the Software Process / Humphrey G. — Reading: Addison-Wesley, 1989 • Controlling Software Projects / DeMarco T. — Englewood Cliffs: Prentice Hall, 1982

Mathematical methods for scientific research

Scientific supervisor:	Olga Afanasieva, PhD, Associate professor;
Module code:	Б.1.В.ДВ.1, elective module
Lesson types:	Lectures, laboratory work, individual work
Description:	This module helps students to prepare for the MSc thesis preparation from the formal theories point of view. It gives elements of mathematical statistics and probabilities theory and basics of operations research methods. This knowledge would be useful for students to prove that the developed format methods and algorithms operate correctly and give the better results than the already existing ones.
Semester, duration:	S1, 72 hours.
Knowledge evaluation:	Pass-fail test
Documentation:	Useful literature.
Language:	English or Russian.
Competences:	• Development of a methodology for performing analytical work.
Recommended literature:	• Christofides H. Graph theory : An algorithmic approach - M. : Mir, 1978. - 432 p. • Seshu, Sundaram. Linear Graphs & Electrical Networks. Massachusetts ; London : Addison-Wesley Publishing Co, 1961. - 315 p. • Herari F. Graph theory. M. : Mir, 1973. - 300 p. • http://znanium.com/bookread

Embedded systems interfaces

Scientific supervisor:	Eugeniy Yablokov, PhD, Associate professor;
Module code:	Б.1.В.ДВ.1, elective module
Lesson types:	Lectures, practical work, individual work
Description:	The content of the module covers a range of issues related to modern data transfer interfaces at the physical, channel, network and transport layers of the OSI model. Module gives a deep knowledge on modern communication standards like FibreChannel, HyperTransport, PCIExpress, RapidIO and SpaceWire.
Semester, duration:	S1, 72 hours.
Knowledge evaluation:	Pass-fail test
Documentation:	Useful literature.
Language:	Russian.
Competences:	• Development of a methodology for performing analytical work. • Scientific guidance in the relevant field of knowledge.
Recommended literature:	• Roger Hu. Embedded System Architecture and Hardware Design. RandSpace Technology. 2020. 313 p. • Communication standards specifications. • ESA (European Space Agency). Standard ECSS-E-50-12C rev.1, “SpaceWire – Links, nodes, routers and networks”. Noordwijk: ESA Publications Division ESTEC, 2019. 123 p.

Methodology of scientific cognition

Scientific supervisor:	Sergey Kolomiytsev, PhD, Associate professor;
Module code:	Б.1.Б.2, base module
Lesson types:	Lectures, consultations, individual work
Description:	This module gives fundamental knowledge on history of science and philosophy. It gives notions on subject and basic concepts of modern philosophy of science. A significant part of the module is devoted to the origination of science and the main stages of its historical evolution from pre-science to the science of 19th century. The module also includes information on the structure of scientific knowledge and dynamics of science as a process of generating new knowledge
Semester, duration:	S1, 72 hours.
Knowledge evaluation:	Pass-fail test
Documentation:	Lectures in electronic form, useful literature.
Language:	English or Russian.
Competences:	• Critical analysis of problem situations based on a systematic approach, development of an action strategy. • Independent acquisition, development and application of mathematical, natural science, socio-economic and professional knowledge in order to solve non-standard problems, including those in a new or unfamiliar environment and in an interdisciplinary context.
Recommended literature:	• Kolomiytsev S. Yu. History of Philosophy of Science: from XIX to beginning of XXI: guide. Spb.: SUAI, 2016. - 196 p. • F. Danneman. Die Naturwissensvhaften in Ihrer Entwicklung und in Ihrem Zusammenhange - 3-rd ed. - M.: URSS: Librocom, 2012. - 384 p. • Cont O. Discours sur l'esprit positif. 3-е изд. - M.: URSS: Librocom, 2012. - 80 p. • Orlov V. V. Philosophy of economics. Univ. Of Perm - 2-nd ed., 2006. - 266 p.

Systems modeling

Scientific supervisor:	Valentin Olenev, PhD, Head of department;
Module code:	Б.1.В.ДВ.6, elective module
Lesson types:	Lectures, practical work, individual work
Description:	This module is intended to give the knowledge in modeling of different types of systems. It is related to both formal and software modeling. Module includes basic concepts and definitions of modeling theory, different classifications models and mathematical modeling schemes. As the formal theory module is focused on Petri nets, its analysis and different types of Petri Nets. From the software modeling point of view current module is focused on SystemC modeling language, its main concepts and program implementation rules.
Semester, duration:	S2, 72 hours.
Knowledge evaluation:	Tests during the semester, discussions, project defense, pass-fail test
Documentation:	Lectures in electronic form, useful literature, study guide.
Language:	English.
Competences:	• Development of methods for performing analytical work • Integration and implementation of developed software, computing systems, communication equipment • Scientific guidance in the relevant field of knowledge.
Recommended literature:	• James L. Peterson. Petri Nets / Department of Computer Sciences, Computing Surveys, Vol 9, No. 3, The University of Texas, 1977, p. 1-30 • Mani Balakrishnan. Introduction to Petri Nets / Advanced Switching Theory and Logic Design, 2010, p. 1-14 • http://accellera.org/downloads/standards/systemc

Specification and modelling languages

Scientific supervisor:	Alexey Rabin, PhD, Head of department;
Module code:	Б.1.В.ДВ.6, elective module
Lesson types:	Lectures, laboratory work, individual work
Description:	The content of the module covers software simulation using the SDL specification and description language, studying the SDL language, its areas of application, writing specifications in the SDL language. Module gives a useful experience in implementation of technical specifications in terms of formal language, with gives ability to verify the specifications.
Semester, duration:	S2, 72 hours.
Knowledge evaluation:	Tests during the semester, discussions, project defense, pass-fail test
Documentation:	Lectures in electronic form, useful literature, study guide.
Language:	Russian.
Competences:	• Development of methods for performing analytical work
Recommended literature:	• International Telecommunication Union. Recommendation Z100: Specification and Description Language (SDL). 2007. • International Telecommunication Union. Recommendation Z100. Annex F: SDL formal definition: General Overview. 2000. • Jan Ellsberger, Dieter Hogrefe, Amardeo Sarma "SDL: formal object-oriented language for communicating systems", Prentice Hall, 1997. • A. Mitschele-Thiel. Systems Engineering with SDL: Developing Performance-Critical Communication Systems. Wiley, 2001. 380 p. • L. Doldi. Validation of Communications Systems with SDL: The Art of SDL Simulation and Reachability Analysis. Wiley, 2003. 310 p.

Systems for digital signal processing

Scientific supervisor:	Vadim Lutsiv, doctor of science, Professor;
Module code:	Б.1.В.ДВ.5, elective module
Lesson types:	Lectures, laboratory work, individual work, consultations.
Description:	This module is related to one of the embedded systems application areas, which is digital signal processing. It discusses basic concepts of computer vision systems and pattern recognitions. Then it overviews artificial neural networks that implement the construction of a discriminatory surface in the attribute space and finishes with invariant image descriptions. This module proves that embedded systems could be used not only for critical spheres of life, like nuclear or space, but also in everyday life.
Semester, duration:	S2, 108 hours.
Knowledge evaluation:	Final exam.
Documentation:	Lectures in electronic form, useful literature, study guide.
Language:	English or Russian.
Competences:	• Development of methods for performing analytical work • Scientific guidance in the relevant field of knowledge.
Recommended literature:	• Lutsiv V. R., Nedoshivina L. S., Methods of image processing and recognition. Manual of practical investigation. – Saint Petersburg: SUAI, 2019. – 60 p. • Bradski G. and Kaehler A. Learning OpenCV. Beijing, Cambridge, Farnham, Köln, Sebastopol, Taipei, Tokyo: O'Reilly Media, Inc., 2008. 556 p. • Gonzalez R.C., Woods R.E. Digital image processing. – Upper Saddle River, New Jersey: Prentice Hall, 2002. • Gonsales R.C., Woods R.E., Eddins S.L. Digital image processing using MATLAB. – Upper Saddle River, New Jersey: Prentice Hall, 2004. • Shapiro L.G., Stockman G.C. Computer vision. – Upper Saddle River, New Jersey: Prentice Hall, 2001.

Optimization methods

Scientific supervisor:	Tatyana Solovieva, PhD, associate professor;
Module code:	Б.1.Б.7, base module
Lesson types:	Lectures, laboratory work, individual work.
Description:	Module covers a range of issues related to methods of optimization of complex systems, finding weaknesses in technical systems. The complexity of the system is understood as such qualities of the system as: lack of information about the functioning of the system, in particular, the uncertainty (incompleteness, inaccuracy, fuzziness) of the initial data, structural, computational complexity, multi-criteria, multi-extremity.
Semester, duration:	S2, 180 hours.
Knowledge evaluation:	Pass-fail test
Documentation:	Lectures in electronic form, useful literature.
Language:	English or Russian.
Competences:	• Independent acquisition, development and application of mathematical, natural science, socio-economic and professional knowledge in order to solve non-standard problems, including those in a new or unfamiliar environment and in an interdisciplinary context • Development of original algorithms and software, also using modern intelligent technologies, to solve professional problems • Practical application of new scientific principles and research methods • Development of components of software and hardware systems for information processing and computer-aided design.
Recommended literature:	• S. A. Andronov. Analytical modeling in logistics. SPb.: SUAI, 2012. - 140 p. • S. A. Andronov. Models and methods in systems for decision support. SPb. : SUAI, 2008. - 176 p. • A. V. Antonov. Systems analysis - 3-rd ed. - M.: High school, 2008. - 453 p.

Intellectual systems

Scientific supervisor:	Roman Malashin, PhD, associate professor;
Module code:	Б.1.Б.4, base module
Lesson types:	Lectures, laboratory work, individual work.
Description:	Intellectual systems module gives the introduction to artificial intelligence and its main paradigms, representation of problems in the state space and algorithms for finding solutions. State Spaces and their classification. Search tasks, uninformed and informed search procedures. The module further covers semantic networks and applied ontologies, production systems in artificial intelligence tasks, the task of satisfying constraints.
Semester, duration:	S2, 216 hours.
Knowledge evaluation:	Final exam
Documentation:	Lectures in electronic form, useful literature.
Language:	English or Russian.
Competences:	• Application of modern communication technologies, also in a foreign language, for academic and professional interaction • Independent acquisition, development and application of mathematical, natural science, socio-economic and professional knowledge in order to solve non-standard problems, including those in a new or unfamiliar environment and in an interdisciplinary context • Development of original algorithms and software, also using modern intelligent technologies, to solve professional problems.
Recommended literature:	• Sovetov B.Ya. Representation of knowledge on information systems - M.: Akademiya, 2011. - 144 p. • D. A. Pospelov. Artificial intelligence: 3 books. Book 2: Models and methods. - M.: Radio and telecom, 1990 - 304 p.

Systems- and Networks-on-Chip

Scientific supervisor:	Elena Suvorova, PhD, associate professor;
Module code:	Б.1.В.3, elective module
Lesson types:	Lectures, laboratory work, individual work.
Description:	In this module students get knowledge on design of systems- and networks-on-chip. System-on-a-chip technology is used in small, increasingly complex electronic devices. The module covers such significant topics as IP block design of the external interface controller and designing the SoC on the basis of the required characteristics of the IP blocks. Moreover, the module gives notions on conformity assessment of the characteristics of a given SoC to the required values. Students are given recommendations on how to improve time and power consumption characteristics.
Semester, duration:	S2, 72 hours.
Knowledge evaluation:	Pass-fail test
Documentation:	Lectures in electronic form, useful literature.
Language:	English or Russian.
Competences:	• Integration and implementation of developed software, computing systems, communication equipment • Development of means and systems for data protection of automated systems • Synthesis of logic circuits in the basis of the selected technological library based on the specified time and physical constraints using computer-aided design tools.
Recommended literature:	• V. P. Babak. VHDL: user guide on language basics - M. : DODEKA-XXI, 2008. - 224 p. • P. N. Bibilo. VHDL language basics. - M. : Solon-P, 2000. - 200 p. • Suvorova E.A., Sheynin Yu. E. VHDL for VLSI design. SUAI, 2001. – 211 p.

Transmission of discrete messages

Scientific supervisor:	Felix Taubin, doctor of science, Professor;
Module code:	Б.1.В.ДВ.4, elective module
Lesson types:	Lectures, laboratory work, individual work.
Description:	The content of the discipline covers a range of issues related to the construction and operation of information transfer systems. The focus is on studying modern methods of building and analyzing information transfer algorithms and acquiring practical skills in the development of basic functional subsystems of information transfer systems. The module covers such topics as the structure of the system of transmission of discrete messages, the main types of discrete modulation, channel coding.
Semester, duration:	S2, 72 hours.
Knowledge evaluation:	Pass-fail test
Documentation:	Lectures in electronic form, useful literature.
Language:	English or Russian.
Competences:	• Integration and implementation of developed software, computing systems, communication equipment
Recommended literature:	• B. Sklyar. Digital communications. Fundamentals and Applications: 2-nd ed. – M. : Viliams, 2003. - 1099 p. • A.N. Trophymov. Digital communications theory basics: user guide – SPb.: SUAI, 2015, - 184 p. • V.A. Galkin. Digital mobile radio-communications: users guide – M.: Hot line – Telecom, 2007. - 432 p.

Architecture of parallel computing systems

Scientific supervisor:	Elena Suvorova, PhD, associate professor;
Module code:	Б.1.Б.8, base module
Lesson types:	Lectures, practical work, seminars, individual work.
Description:	The core overviews architecture of parallel computational system, its classification, SMP architecture. Computers with shared memory, memory conflicts on performance, distributed computing environments. Performance evaluation, network latency. Then the module moves to the computational systems based on graphic processors, in particular Hybrid Computation Model, different algorithms and methods for memory organization. Last part of the module covers distributed computational systems. It is distributed file system, algorithms on map reduce, graphs in map-reduce, shortest path in the graph.
Semester, duration:	S2, 180 hours.
Knowledge evaluation:	Final exam
Documentation:	Lectures in electronic form, useful literature.
Language:	English or Russian.
Competences:	• Application of modern communication technologies, also in a foreign language, for academic and professional interaction • Development of original algorithms and software, also using modern intelligent technologies, to solve professional problems • Development and modernization of software and hardware for information and automated systems. • Development of components of software and hardware systems for information processing and computer-aided design.
Recommended literature:	• Guseva A. I. Computing systems, networks and telecommunications - M.: Akademia, 2014. - 288 p. • S.A. Orlov. Organisation of PC and systems. Fundamental module for the architecture and structure of modern computer facilities - 3-rd ed. - SPb. : PITER, 2014. - 688 p. • A. Tannenbaum. Computer architecture. - 4-th ed. - M..: Piter, 2005. - 698 p.

Information safety and security

Scientific supervisor:	Sergey Bezzateev, doctor of science, Professor;
Module code:	Б.1.Б.6, base module
Lesson types:	Lectures, practical work, consultations, individual work.
Description:	This module gives the knowledge in information security field. During the module students learn about different ways of protection against unauthorized access. Moreover, a significant part of the module is related to cryptographic methods of information security such as symmetric ciphers, systems with public keys and EDS systems. Students also are given lectures on information security in global networks as nowadays it is a very big problem.
Semester, duration:	S3, 216 hours.
Knowledge evaluation:	Final exam
Documentation:	Lectures in electronic form, useful literature.
Language:	English or Russian.
Competences:	• Critical analysis of problem situations based on a systematic approach, development of an action strategy. • Independent acquisition, development and application of mathematical, natural science, socio-economic and professional knowledge in order to solve non-standard problems, including those in a new or unfamiliar environment and in an interdisciplinary context • Practical application of new scientific principles and research methods.
Recommended literature:	• Romankov V.A. Introduction to cryptography - 2-nd edition., - M. : FORUM, 2012. - 240 p. • Ryabko B. Ya. Cryptographic methods for information security - 2-nd ed. - M. : Hot Line – Telecom. 2014. - 229 p. • Shnayer B. Applied cryptography: Protocols, algorithms, source codes in the C language- M. : Triumf, 2003. - 815 p.

Systems for digital image processing

Scientific supervisor:	Vadim Lutsiv, doctor of science, Professor;
Module code:	Б.1.В.5, elective module
Lesson types:	Lectures, laboratory work, consultations, individual work.
Description:	This module is related to digital image processing in modern systems. During the module students get knowledge on the methods of local images analysis. The module gives notions on use of artificial neural network for solving the image processing tasks. Moreover, master students are given knowledge on such popular image processing algorithms as SIFT, ASIFT, SURF and the latest solutions in the field of automatic classification of images (e.g. HOG). The module includes a practical part during which students can apply their new knowledge.
Semester, duration:	S3, 108 hours.
Knowledge evaluation:	Final exam
Documentation:	Lectures in electronic form, useful literature, study guide.
Language:	English or Russian.
Competences:	• Development of methods for performing analytical work • Scientific guidance in the relevant field of knowledge.
Recommended literature:	• Lutsiv V. R., Nedoshivina L. S., Methods of image processing and recognition. Manual of practical investigation. – Saint Petersburg: SUAI, 2019. –60 p • Bradski G. and Kaehler A. Learning OpenCV. Beijing, Cambridge, Farnham, Köln, Sebastopol, Taipei, Tokyo: O'Reilly Media, Inc., 2008. 556 p. • Gonzalez R.C., Woods R.E. Digital image processing. – Upper Saddle River, New Jersey: Prentice Hall, 2002. • Gonsales R.C., Woods R.E., Eddins S.L. Digital image processing using MATLAB. – Upper Saddle River, New Jersey: Prentice Hall, 2004. • Shapiro L.G., Stockman G.C. Computer vision. – Upper Saddle River, New Jersey: Prentice Hall, 2001.

On-board computing networks

Scientific supervisor:	Valentin Olenev, PhD, Head of department;
Module code:	Б.1.В.2, elective module
Lesson types:	Lectures, seminars, individual work.
Description:	This module gives useful information on communication systems and buses for embedded and onboard computing and control systems and overview of different technologies, networks and buses that are used for onboard systems of aircraft and spacecraft. Module is focused on serial interfaces and communication buses, serial peripheral interface SPI, I2C serial bus, ARINC 429 buses for avionics and so on. From the technologies that are related to aerospace - onboard avionics bus MIL-STD-1553B and new generation communication systems for onboard avionics and spacecraft systems AFDX, SpaceWire, SpaceFibre.
Semester, duration:	S3, 72 hours.
Knowledge evaluation:	Pass-fail test
Documentation:	Lectures in electronic form, useful literature, study guide.
Language:	English or Russian.
Competences:	• Integration and implementation of developed software, computing systems, communication equipment. • Development of means and systems for data protection of automated systems.
Recommended literature:	• Guseva A. I. Computing systems, networks and telecommunications - M.: Akademia, 2014. - 288 p. • Kojanov Yu. F., Kolbanyov M.O. Next Generation Network Interfaces and Protocols: Theory and Practice. SPb.: SUAI, 2010.

Computer networks and telecommunications

Scientific supervisor:	Vladimir Ivanov, PhD, associate professor;
Module code:	Б.1.В.4, elective module
Lesson types:	Lectures, laboratory work, individual work.
Description:	This module describes the foundations of computer networks building, intellectual communication networks, principles for the implementation of mobile radio networks, features of the construction of telecommunication networks using optical communications. Moreover, module describes integrated communications networks, networking standards and algorithms for network topologies.
Semester, duration:	S3, 144 hours.
Knowledge evaluation:	Final exam
Documentation:	Lectures in electronic form, useful literature.
Language:	English or Russian.
Competences:	• Integration and implementation of developed software, computing systems, communication equipment. • Development of means and systems for data protection of automated systems. • Scientific guidance in the relevant field of knowledge.
Recommended literature:	• Barteskas D., Gallager R. Data transmission networks – M.: Mir, 1989 • Olifer V.G., Olifer N.A.. Computer networks. Principles, technologies, protocols: Textbook for universities. 4-th ed. – Spb.: Piter, 2012. – 944 p. • V. Stollings. Modern communication networks. 2-nd ed. /. – SPb.: Piter, 2003. • M. Kuligin. Corporative networks technologies. – SPb.: Piter, 1999. – 700 p.

Artificial neural networks

Scientific supervisor:	Roman Malashin, PhD, associate professor;
Module code:	Б.1.В.ДВ.3, elective module
Lesson types:	Lectures, laboratory work, individual work.
Description:	The module is devoted to deep neural networks for machine learning. It covers basic concepts of artificial neurons, activation functions, neuronal weights, backpropagation, and regularization methods. Modern architectures including convolutional and recurrent neural networks are considered. Artificial neural networks discussed in the module have wide spectrum of applications like object recognition, image enhancement and text analysis.
Semester, duration:	S3, 144 hours.
Knowledge evaluation:	Final exam
Documentation:	Lectures in electronic form, useful literature.
Language:	English or Russian.
Competences:	• Integration and implementation of developed software, computing systems, communication equipment. • Development of means and systems for data protection of automated systems.
Recommended literature:	• Goodfellow I, Bengio Y., Courville A. Deep learning. Cambridge, Massachusetts, U.S.: MIT Press, 2016. 800 p. • M. Hassoun. Fundamentals of Artificial Neural Networks. US.: MIT Press. 2003. 540 p.

Entrepreneurship basics

Scientific supervisor:	Ekaterina Karasyova, PhD, associate professor;
Module code:	Б.1.Б.3, base module
Lesson types:	Lectures, practical work, individual work.
Description:	Current module gives a basic knowledge in the area of entrepreneurship. In particular it starts with fundamentals of international entrepreneurship, legal and organizational, managerial and economic foundations of entrepreneurship. Also the module covers methods for evaluating the effectiveness of the enterprise, taking into account its cost and quality management. It will help students to get the main basis for the new start-ups and business from the economic and law point of view.
Semester, duration:	S3, 180 hours.
Knowledge evaluation:	Pass-fail test
Documentation:	Lectures in electronic form, useful literature.
Language:	English or Russian.
Competences:	• Analysis of professional information, identification of its essence, structuring and presentation as analytical reviews with reasoned conclusions and recommendations • Practical application of new scientific principles and research methods.
Recommended literature:	• Peter F. Drucker. Innovation and entrepreneurship. Practice and Principles. – 1985. 294 p. • Thierry Burger-Helmchen. Entrepreneurship - Creativity and Innovative Business Models – 2014. 190 p.

Teaching practice

Scientific supervisor:	Natalia Shekhunova, PhD, professor;
Module code:	Б.2.Б.3, base module
Description:	Master students act as tutors and assistants during the practical parts of the modules. Teaching practice gives students knowledge of communication with students from the position of the leader. Also it gives evaluation, communication skills.
Semester, duration:	S3, 34 hours.
Knowledge evaluation:	Final report
Documentation:	Depending on the module
Language:	English or Russian.
Competences:	• Organization and management of team work, developing a team strategy to achieve the goal • Application of modern communication technologies, also in a foreign language, for academic and professional interaction • Analysis and consideration of cultural diversity in the process of intercultural interaction.
Recommended literature:	Depending on a module

Industrial practice

Scientific supervisor:	Natalia Shekhunova, PhD, professor;
Module code:	Б.2.В.2, elective module
Description:	Master students participate in the projects or get individual tasks from the industrial partners. They prepare the final report and get the real industrial experience.
Semester, duration:	S3, 34 hours.
Knowledge evaluation:	Final report
Documentation:	Presentations, technical literature
Language:	English or Russian.
Competences:	• Critical analysis of problem situations based on a systematic approach, development of an action strategy. • Determination and implementation of priorities of one's own activities and ways to improve them based on self-assessment.
Recommended literature:	Depending on a project area

Contact details

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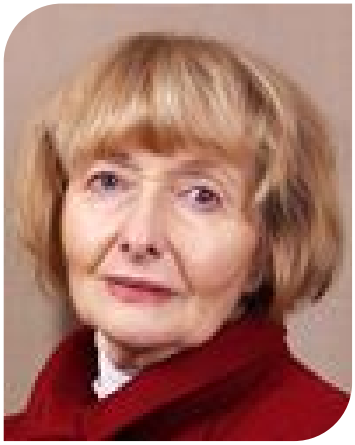

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