

In this paper we consider only the sub-disciplines related to computing in accordance with the papers of the ACM, IEEE-CS, AIS, and AITP expert group.

The typical degrees offered within this subject area in the Russian Federation are presented in table 3.

Table 3
Typical degrees in ICT

Cycle	Degree	Qualification awarded	ECTS credits
1 st cycle	010000 PHYSICAL AND MATHEMATICAL SCIENCE		
	010200 Mathematics and Computer Science	Bachelor	240
	010300 Fundamental Computer Science and Information Technologies	Bachelor	240
	010400 Applied Mathematics and Computer Science	Bachelor	240
	010500 Software and Information Systems Management	Bachelor	240
	080000 ECONOMICS AND MANAGEMENT		
	080500 Business Informatics	Bachelor	240
	210000 ELECTRONIC ENGINEERING, RADIO TECHNOLOGY AND COMMUNICATION		
	210700 Information and Communication Technologies and Communication Systems	Bachelor	240
	230000 COMPUTER SCIENCE AND COMPUTER ENGINEERING		
	230100 Computer Science and Computer Engineering	Bachelor	240
	230400 Information Systems and Technologies	Bachelor	240
	230700 Applied Computer Science	Bachelor	240
	231000 Software Engineering	Bachelor	240
	231300 Applied Mathematics	Bachelor	240
	090000 INFORMATION SECURITY		
	090900 Information Security	Bachelor	240

Cycle	Degree	Qualification awarded	ECTS credits
2 nd cycle	010000 PHYSICAL AND MATHEMATICAL SCIENCE		
	010200 Mathematics and Computer Science	Master	120
	010300 Fundamental Computer Science and Information Technologies	Master	120
	010400 Applied Mathematics and Computer Science	Master	120
	010500 Software and Information Systems Management	Master	120
	080000 ECONOMICS AND MANAGEMENT		
	080500 Business Informatics	Master	120
	210000 ELECTRONIC ENGINEERING, RADIO TECHNOLOGY AND COMMUNICATION		
	210700 Information and Communication Technologies and Communication Systems	Master	120
	230000 COMPUTER SCIENCE AND COMPUTER ENGINEERING		
	230100 Computer Science and Computer Engineering	Master	120
	230400 Information Systems and Technologies	Master	120
	230700 Applied Computer Science	Master	120
	231000 Software Engineering	Master	120
	231300 Applied Mathematics	Master	120
	090000 INFORMATION SECURITY		
	090900 Information Security	Master	120
2 nd cycle	090300 INFORMATION SECURITY OF COMPUTING, AUTOMATED AND TELECOMMUNICATION SYSTEMS		
	090301 Computer Security	Specialist	330
	090302 Information Security of Telecommunication Systems	Specialist	330
	090303 Information Security of Automated Systems	Specialist	300
	090305 Information Analysis Security Systems	Specialist	330

carried out with graduates, students, employers and academics as outlined above. In order to identify the list of competences to be used as the basis of the wider consultation, the following process was carried out by the participants in the Tuning Russia project.

1. The Russian members of each SAG drew up initial lists of the generic competences they considered to be the key ones.
2. The lists were discussed by Russian members of each SAG and with EU experts and were amended if it was considered as necessary.
3. The lists proposed by the SAGs were compared and the following categories of competences were distinguished: the common core of generic competences selected by all SAGs; competences selected by the majority of SAGs; those selected only by some SAGs; and those selected by only one SAG.
4. The list of 30 generic competences was agreed and its Russian and English versions were established in order to be used during the consultation process.
5. Students, employers, graduates and academics were consulted.
6. The questionnaires were analysed and the final list of generic competences, common for all the Project SAGs was drawn. The results were discussed by all SAGs.

The final list comprises the following 30 competences:

Table 5
Full list of generic competences

Competence code	Competence
[GC-01]	Ability for abstract thinking, analysis and synthesis
[GC-02]	Ability to work in a team
[GC-03]	Capacity to generate new ideas (Creativity)
[GC-04]	Ability to identify, pose and resolve problems
[GC-05]	Ability to design and manage projects
[GC-06]	Ability to apply knowledge in practical situations

Competence code	Competence
[GC-07]	Ability to communicate in a second language
[GC-08]	Skills in the use of information and communication technologies
[GC-09]	Capacity to learn and stay up-to-date with learning
[GC-10]	Ability to communicate both orally and in written form in the native language
[GC-11]	Ability to work autonomously
[GC-12]	Ability to make reasoned decisions
[GC-13]	Ability for critical thinking
[GC-14]	Appreciation of and respect for diversity and multiculturality
[GC-15]	Ability to act with social responsibility and civic awareness
[GC-16]	Ability to act on the basis of ethical reasoning
[GC-17]	Commitment to the conservation of the environment
[GC-18]	Ability to communicate with non-experts of one's field
[GC-19]	Ability to plan and manage time
[GC-20]	Ability to evaluate and maintain the quality of work produced
[GC-21]	Ability to be critical and self-critical
[GC-22]	Ability to search for, process and analyse information from a variety of sources
[GC-23]	Commitment to safety
[GC-24]	Interpersonal and interactional skills
[GC-25]	Ability to undertake research at an appropriate level
[GC-26]	Knowledge and understanding of the subject area and understanding of the profession
[GC-27]	Ability to resolve conflicts and negotiate
[GC-28]	Ability to focus on quality
[GC-29]	Ability to focus on results
[GC-30]	Ability to innovate

5.2.3. Subject specific competences

In order to form a synthesized list of professional competences for the ICT subject area, the educational standards for degrees being implemented in the universities of ICT subject area group were analysed.

We considered the Federal State Educational Standards (FSES) as well as the Universities Educational Standards (UES) for National Research Universities:

Type	Degree	University implementing degree (in SAG)
FSES	010300 Fundamental Computer Science and Information Technologies	N.I. Lobachevsky State University of Nizhniy Novgorod
UES	010300 Fundamental Computer Science and Information Technologies	N.I. Lobachevsky State University of Nizhniy Novgorod
FSES	230100 Computer Science and Computer Engineering	Yaroslav-the-Wise Novgorod State University
FSES	230400 Information Systems and Technologies	Astrakhan State University
FSES	230700 Applied Computer Science	North Caucasus State Technical University

The list of 16 synthesized professional competences which is presented in table 6, is the result of a comparative analysis of professional competences, regrouping connected competences, a comparative analysis of educational degrees being implemented in Russian universities with international professional educational standards in the ICT area called Computing Curricula.

Table 6
Full list of subject specific competences

Competence code	Competence
[SSC-01]	To analyze subject area, identify, classify and describe problems; find the methods and approaches for solving them; define requirements

Competence code	Competence
[SSC-02]	To design ICT systems, including modelling (formal description) of structure and processes
[SSC-03]	To develop and implement ICT systems
[SSC-04]	To deploy, install, integrate, put into service and maintain ICT systems and their elements
[SSC-05]	To guarantee the quality of information systems according to the requirements
[SSC-06]	To develop and bring into effect new competitive ideas in the area of ICT
[SSC-07]	To know, follow and assess the degree of compliance with industry specifications, standards, regulations, and recommendations
[SSC-08]	To analyze, choose and apply methods and aids to provide information security
[SSC-09]	To manage economic, human, technological and other resources efficiently
[SSC-10]	To train ICT users and provide them with technical support
[SSC-11]	To apply and develop fundamental and multidisciplinary knowledge, including mathematical and scientific principles, quantitative methods, tools (including software relevant to their engineering discipline) and notations for successful problem solving
[SSC-12]	To prepare technical and methodical materials for presenting ICT system in every stages of the life cycle of information systems
[SSC-13]	To know and apply core ICT theoretical and practical knowledge, principles and tools
[SSC-14]	To appreciate the social considerations and ethical issues affecting the professional practice
[SSC-15]	To estimate and appreciate economic and commercial issues affecting the professional practice
[SSC-16]	To collect, process and systematize professional knowledge in information technology and appreciate the importance of life-long learning (continuing education, retraining, and self-learning) for the necessary adaptation to the evolution of the profession and society

Table 9
Meta-competences for ICT area

Key competences	Other competences
[MGC-1] Ability to perceive, analyze and synthesize information	
<p>[GC-07] Ability to communicate in a second language</p> <p>[GC-10] Ability to communicate both orally and in written form in the native language</p> <p>[GC-22] Ability to search for, process and analyse information from a variety of sources</p> <p>[GC-01] Ability for abstract thinking, analysis and synthesis</p>	<p>[GC-04] Ability to identify, pose and resolve problems</p> <p>[GC-12] Ability to make reasoned decisions</p> <p>[GC-13] Ability for critical thinking</p>
[MGC-2] Ability for self-development and self-improvement	
<p>[GC-09] Capacity to learn and stay up-to-date with learning</p> <p>[GC-29] Ability to focus on results</p>	<p>[GC-11] Ability to work autonomously</p> <p>[GC-19] Ability to plan and manage time</p> <p>[GC-23] Commitment to safety</p> <p>[GC-14] Appreciation of and respect for diversity and multiculturality</p> <p>[GC-15] Ability to act with social responsibility and civic awareness</p> <p>[GC-21] Ability to be critical and self-critical</p> <p>[SSC-16] To collect, process and systematize professional knowledge in information technology and appreciate the importance of life-long learning (continuing education, retraining, and self-learning) for the necessary adaptation to the evolution of the profession and society</p>

Key competences	Other competences
[MGC-3] Ability to join professional community	
<p>[GC-26] Knowledge and understanding of the subject area and understanding of the profession</p> <p>[GC-02] Ability to work in a team</p> <p>[GC-06] Ability to apply knowledge in practical situations</p>	<p>[GC-25] Ability to undertake research at an appropriate level</p> <p>[GC-30] Ability to innovate</p> <p>[GC-18] Ability to communicate with non-experts of one's field</p> <p>[GC-20] Ability to evaluate and maintain the quality of work produced</p> <p>[GC-27] Ability to resolve conflicts and negotiate</p> <p>[GC-03] Capacity to generate new ideas (creativity)</p> <p>[GC-28] Ability to focus on quality</p> <p>[GC-16] Ability to act on the basis of ethical reasoning</p> <p>[GC-17] Commitment to the conservation of the environment</p> <p>[GC-24] Interpersonal and interaction skills</p> <p>[SSC-14] To appreciate the social considerations and ethical issues affecting the professional practice</p>
[MSSC-1] Ability to understand, apply and develop mathematical knowledge, basic laws of natural science, knowledge in problem domain (related to professional activity) and fundamentals of information technologies (related to Computer Science sub-discipline of CC2005)	
<p>[SSC-11] To apply and develop fundamental and multidisciplinary knowledge, including mathematical and scientific principles, quantitative methods, tools (including software relevant to their engineering discipline) and notations for successful solving problems</p> <p>[SSC-06] To develop and bring into effect new competitive ideas in the area of ICT</p> <p>[SSC-08] To analyze, choose and apply methods and aids to provide information security</p>	<p>[SSC-13] To know and apply core ICT theoretical and practical knowledge, principles and tools</p> <p>[GC-08] Skills in the use of information and communications technologies</p>

Key competences	Other competences
[MSSC-2] Ability to design, develop, implement and manage life cycle processes of information systems and technologies (related to Information Systems and Technologies sub-discipline of CC2005)	
<p>[GC-05] Ability to design and manage projects</p> <p>[SSC-01] To analyze subject area, identify, classify and describe problems; find the methods and approaches for their solving; define requirements</p> <p>[SSC-02] To design ICT systems, including modelling (formal description) of structure and processes</p> <p>[SSC-03] To develop and implement ICT systems</p> <p>[SSC-04] To deploy, install, integrate, put into service and maintain ICT systems and their elements</p> <p>[SSC-05] To guarantee the quality of information systems according to the requirements</p> <p>[SSC-07] To know, follow and assess the degree of compliance with industry specifications, standards, regulations, and recommendations</p> <p>[SSC-10] To train ICT users and provide them technical support</p>	<p>[SSC-09] To manage economic, human, technological and other resources efficiently</p> <p>[SSC-12] To prepare technical and methodical materials for presenting ICT system in every stages of the life cycle of information systems</p> <p>[SSC-15] To estimate and appreciate economic and commercial issues affecting the professional practice</p>

The core element of the final set of meta-competences is the ability to join the professional community (MGC-3). This meta-competence is achieved by mastering:

- generic meta-competences – the ability to perceive, analyse and synthesize information (MGC-1) on the one hand, and the ability for self-development and self-improvement (MGC-2) on the other hand;
- subject-specific meta-competences – the ability to understand, apply and develop mathematical knowledge, basic laws of natural science

First-cycle graduates (Bachelors) and the second-cycle graduates (Masters) should

Competence	Learning outcomes for Bachelors	Learning outcomes for Masters
<p>[SSC-01] To analyse subject area, identify, classify and describe problems; find the methods and approaches for their solving; define requirements</p> <p>[SSC-02] To design ICT systems, including modelling (formal description) of structure and processes</p>	<ul style="list-style-type: none"> To know and understand the methods of analysis of problem domain, requirements identification and gathering source data for design; To carry out an initial investigation (engineering) of the design object, system analysis of a problem domain and the corresponded relationships; To know, understand and apply the basic design methods and techniques (technical and implementation) of information systems and technologies; To choose input data for design; To develop, make agree and deliver all kinds of project documentation; To carry out modelling of basic information processes and systems; To carry out activities on computational experiments in order to verify the mathematical models being used, document modelling results; 	<ul style="list-style-type: none"> To know, understand and apply the methods of analysis of problem domain, requirements identification and gathering source data for design; To carry out an initial investigation (engineering) of the design object, system analysis of a problem domain and the corresponded relationships; To check, compare, analyze and estimate risks and result of experimental research, draw conclusions on the analysis results; To evaluate, classify and reasonably choose the methods of identification of information systems requirements, formulate requirements; To know, understand and apply the basic concepts and methodologies for modelling information processes, document modelling results; To evaluate and select methods and models of creating, implementing, operating and monitoring information systems at all the stages of their life cycle; To know, understand and apply the basic design methods and techniques (conceptual, technical and implementation) of information systems and technologies; To develop and evaluate design strategies of an information system; justify, analyze and evaluate design solutions; To choose, analyze and evaluate input data for design; To develop, make agree and deliver all kinds of project documentation; To carry out modelling of basic information processes and systems; To plan and carry out activities on computational experiments in order to verify the mathematical models being used, document modelling results; To analyze, evaluate and select modern tools and computing methods, technologies, algorithmic and software solutions for a concrete professional problem;

Competence	Learning outcomes for Bachelors	Learning outcomes for Masters
<p>[SSC-03]</p> <p>To develop and implement ICT systems</p>	<ul style="list-style-type: none"> To know and understand life cycle processes of information systems; To develop facilities for implementing information technologies (methodical, informational, mathematical, algorithmic, hardware and software); To develop facilities for computer-aided design of information technologies; To develop algorithmic, system and specialized software, database models; To reasonably select programming concepts and languages for solving applied tasks; to apply in practice the system and specialized tools, systems and software packages; 	<ul style="list-style-type: none"> To know, understand, develop and monitor life cycle processes of information systems; To develop facilities for implementing information technologies (methodical, informational, mathematical, algorithmic, hardware and software); To develop facilities for computer-aided design of information technologies; To develop algorithmic, system and specialized software, database models; To reasonably select programming concepts and languages for solving applied tasks; to apply in practice the system and specialized tools, systems and software packages; To conduct an analytical study on the operating parameters of ICT systems for the validation and verification of their compliance to the task, as well as to analyze and provide a critical evaluation of the methods chosen, the facilities of implementation and computer-aided design;
<p>[SSC-04]</p> <p>To deploy, install, integrate, put into service and maintain ICT systems and their elements</p>	<ul style="list-style-type: none"> To know, understand and apply techniques of assembling, configuring, debugging, installing software and hardware systems; To know and understand the methods of integration, interfacing and configuration of ICT, software and hardware; To participate in verification and operational testing of information systems and their components; To draw up instructions for operation of information systems and technologies; To carry out work to ensure the operation and adaptation of information systems at enterprises to the specified functional characteristics; To participate in the activities on the final design and development of IT processes during the preparation of new products; 	<ul style="list-style-type: none"> To know, understand and apply techniques of assembling, configuring, debugging, installing software and hardware systems; To know, understand and apply the methods of integration, interfacing and configuration of ICT, software and hardware; To plan, organize, lead verification and operational testing of information systems and their components; To draw up instructions for operation of information systems and technologies; To carry out work to ensure the operation and adaptation of information systems at enterprises to the specified functional characteristics; To plan, organize, lead the activities on the final design and development of IT processes during the preparation of new products;

Competence	Learning outcomes for Bachelors	Learning outcomes for Masters
<p>[SSC-05]</p> <p>To guarantee the quality of information systems according to the requirements</p>	<ul style="list-style-type: none"> • To know, understand and apply modern models and methods of assessing quality and reliability at all stage of information system life cycle; • To know, understand and apply different methodologies and tools for testing and debugging information systems; • To evaluate the quality and reliability of the design object; • To organize the control of quality of input information; 	<ul style="list-style-type: none"> • To know, understand and apply modern models and methods of assessing quality and reliability at all stage of information system life cycle; • To know, understand and apply different methodologies and tools for testing and debugging information systems; • To evaluate the quality and reliability of the design object; • To analyze results of information systems testing and review design concepts in accordance with these results;
<p>[SSC-06]</p> <p>To develop and bring into effect new competitive ideas in the area of ICT</p>	<ul style="list-style-type: none"> • To formulate, experimentally confirm, justify and implement new competitive ideas, methods, solving techniques under supervision of professors; • To document research results in the form of papers and presentations at scientific conferences; 	<ul style="list-style-type: none"> • To formulate, experimentally confirm, justify and implement new competitive ideas, methods, techniques of solving professional, research, technical tasks including non-typical tasks; • To document research results in the form of papers and presentations at scientific conferences; • To develop scientific, information and educational resources for solving professional and applied tasks related to development and use of information technologies;
<p>[SSC-07]</p> <p>To know, follow and assess the degree of compliance with industry specifications, standards, regulations, and recommendations</p>	<ul style="list-style-type: none"> • To know, understand and apply modern professional standards and other legal documents in the field of ICT; 	<ul style="list-style-type: none"> • To know, understand and apply modern professional standards and other legal documents in the field of ICT;

Competence	Learning outcomes for Bachelors	Learning outcomes for Masters
<p>[SSC-08]</p> <p>To analyse, choose and apply methods and aids to provide information security</p>	<ul style="list-style-type: none"> • To formulate the requirements for information security and data integrity; • To know, understand, analyse, choose and apply professionally facilities for providing information security and data consistency according to a given applied task; 	<ul style="list-style-type: none"> • To formulate the requirements for information security and data integrity; • To know, understand, analyse, choose and apply professionally facilities for providing information security and data consistency according to a given applied task;
<p>[SSC-09]</p> <p>To manage economic, human, technological and other resources efficiently</p>	<ul style="list-style-type: none"> • To cooperate with colleagues, to work in team; • To know the essentials of protecting the production staff and population from accidents, catastrophe, natural disasters and their probable consequences; organize and monitor the production processes suiting the requirements of the environment and work safety control systems; 	<ul style="list-style-type: none"> • To find organizational and managerial solutions for non-standard professional situations and take responsibility for them; • To take management decisions in their professional and social activities; to be a project manager; • To know the essentials of protecting the production staff and population from accidents, catastrophe, natural disasters and their probable consequences; organize and monitor the production processes suiting the requirements of the environment and work safety control systems;
<p>[SSC-10]</p> <p>To train ICT users and provide them technical support</p>	<ul style="list-style-type: none"> • To elaborate (or participate in elaboration) instructions for implementation, operation and maintenance of information systems; 	<ul style="list-style-type: none"> • To elaborate organizational and methodological materials, instructions and directive documents for implementation, operation and maintenance of information systems and services, for teaching users to apply software and hardware systems; teach (choose and use existing techniques, mechanisms, explain, report) users to apply software and hardware systems;

Competence	Learning outcomes for Bachelors	Learning outcomes for Masters
<p>[SSC-11] To apply and develop fundamental and multidisciplinary knowledge, including mathematical and scientific principles, quantitative methods, tools (including software relevant to their engineering discipline) and notations for successful solving problems</p>	<ul style="list-style-type: none"> • To know , understand and apply basic mathematical concepts, methods of system analysis and mathematical modelling; • To know, understand and apply basic laws of natural sciences; • To understand the essence of the information, estimate quantity and meaning of the information, manipulate with different types of information; 	<ul style="list-style-type: none"> • To know , understand and apply basic mathematical concepts, methods of system analysis and mathematical modelling; • To know, understand and apply basic laws of natural sciences; • To understand the essence of the information, estimate quantity and meaning of the information, manipulate with different types of information;
<p>[SSC-12] To prepare technical and methodical materials for presenting ICT system in every stages of the life cycle of information systems</p>	<ul style="list-style-type: none"> • To develop, finalize, validate and issue all the kinds of design documents on every stage of the information systems life cycle; • To demonstrate project results (ones work results); 	<ul style="list-style-type: none"> • To develop, finalize, validate and issue all the kinds of design documents on every stage of the information systems life cycle; • To analyse, coordinate, compile and evaluate project documentation; • To demonstrate project results (ones work results); to draw up individually or in a team (to make and model due to the plan) presentations, scientific and technical reports on the results of the work conducted;
<p>[SSC-13] To know and apply core ICT theoretical and practical knowledge, principles and tools</p>	<ul style="list-style-type: none"> • To know, understand and apply fundamental concepts and basic principles of functioning of instrumental and computational tools of information technologies, the concepts of syntactical and semantic structure and the methods of application of programming languages of general and special purposes, theoretical and methodical basis of programming technology, analysis and application of algorithmic and software solutions; 	<ul style="list-style-type: none"> • To know, understand and apply fundamental concepts and basic principles of functioning of instrumental and computational tools of information technologies, the concepts of syntactical and semantic structure and the methods of application of programming languages of general and special purposes, theoretical and methodical basis of programming technology, analysis and application of algorithmic and software solutions;

Competence	Learning outcomes for Bachelors	Learning outcomes for Masters
<p>[SSC-14]</p> <p>To appreciate the social considerations and ethical issues affecting the professional practice</p>	<ul style="list-style-type: none"> • Understand the social importance of their profession; • To know and respect the professional code of ethics; 	<ul style="list-style-type: none"> • To know and respect the professional code of ethics; • To be capable to make judgements on the effect and consequences of his/her professional activity with due account for social, professional and ethic positions;
<p>[SSC-15]</p> <p>To estimate and appreciate economic and commercial issues affecting the professional practice</p>	<ul style="list-style-type: none"> • To calculate the cost-effectiveness; 	<ul style="list-style-type: none"> • To analyse and estimate costs, calculate the cost-effectiveness and draw up a business plan for scientific, technical and applied problems; • To plan, organize and monitor activities at all the stages of information systems life cycle; • To conduct marketing analysis and reasonably choose the aids and methods of production automatization and informatization of production objects;
<p>[SSC-16]</p> <p>To collect, process and systematize professional knowledge in information technology and appreciate the importance of learning throughout life (continuing education, retraining, and self-learning) for the necessary adaptation to the evolution of the profession and society</p>	<ul style="list-style-type: none"> • To apply methods and tools of cognition, learning and self-control for intellectual evolution, raising the level of culture and professional competency. 	<ul style="list-style-type: none"> • To understand, analyze, carry out the targeted research, select scientific and technical resources necessary for the professional scientific and applied problems based on modern science and technology results; • To acquire new scientific and professional knowledge, to predict the development of information systems and technologies.