South Ural State University

Course Descriptions in Information Science & Computer Engineering
MAJOR: Internet of Things

		ECTS cr
B.01	Methodology of Science	2
B.02	Russian Language in Professional Activity	4
B.03	Basics of Business and Logistics Information Systems	4
B.04	Internet of Things Networks	4
B.05	Hardware and Software support of Cyber-Physical Systems	4
B.06	Mobile applications Development	4
B.07	Machine learning, recognition and decision making	4
B.08	Information Systems Design Management	3
B.09	Design of Intelligent Systems	3
B.10	Internet of Things Technology and Platforms	4
B.11	Distributed Computing Systems	3
B.12	Cyber-Physical Systems	4
B.13	Data Mining and Big Data Processing	4
B.14	Cloud computing technologies	4
B.15	Legal and ethical issues of IoT	3
B.16	Cybersecurity of the Internet of Things	3
B.17	Simulation of the Internet of Things Systems	4
B.18	Sensors for the Internet of Things	3
B.19	Case Recognition and Decision-making	3

B.01	*METHODOLOGY OF SCIENCE* *2 ECTS cr*
Year and Semester	Year 1 Semester 1
Teacher(s)	Valentina Aleeva, Candidate of Science, Associate Professor of System Programming Department.
Aims	The student obtains basic knowledge of history and methodology of information technologies and computer science. Upon completion of the course, the students will be able to use these facts and patterns in their professional activity.
Content	Computer engineering in the pre-electronic era. The history and methodology of creation and development of electronic computers. The history and methodology of creation and development of software. The history and methodology of creation and development of computer networks.
Modes of Study	Lectures 16 h Practical assignments 16 h. Self-study 40 h. Total 72 h
Evaluation	Credit test 60%, Practical assignments 30%, Main test 40%.
Prerequisites	Not supposed

B.03	*BASICS OF BUSINESS AND LOGISTICS INFORMATION SYSTEMS* *3 ECTS cr*
Year and Semester	Year 1 Semester 1
Teacher(s)	Lyudmila Kochegarova, Candidate of Science, Associate Professor of Industrial Economics and Project Management Department
Aims	The student obtains basic knowledge in the field of innovative project management and information logistics systems. Upon completion of the course, the student will be able to design a business plan for an innovative idea, to apply modern project management techniques, to optimize workflows using knowledge in the field of information logistics systems
Content	The concept of an innovative project. Business planning basics. Investment and investment analysis. Main phases of project management. Modern project management techniques: Agile, Scrum, Kanban, Lean. Fundamentals of contract theory: principal-agent models, incomplete contract models. Role of logistic information systems in management

Modes of Study	Lectures 16 h Practical assignments 16 h. Self-study 40 h. Total 72 h
Evaluation	Credit test 40%, practical assignments 60%.
Prerequisites	Not supposed

B.04	***INTERNET OF THINGS NETWORKS 4 ECTS cr***
Year and Semester	Year 1 Semester 1
Teacher(s)	Vasiliy Luzhnov, Senior Lecturer of Information Security Department
Aims	The student obtains basic skills in design and implementation of IoT networks.
Content	Features of IoT as an element of the network architecture. IPv4 and IPv6. IPv6 as a key element of IoT. IoT protocols within the OSI network model. Data link layer protocols (IEEE 802.15.4e, IEEE 802.11 ah, WirelessHART, Z-Wave, Bluetooth Low Energy, Zigbee, LoRaWAN). Network layer protocols (6LoWPAN, 6TiSCH, 6Lo). Session-level protocols (MQTT, SMQTT, AMQP, CoAP, XMPP, DDS). Control protocols in IoT. Security in IoT protocols.
Modes of Study	Practical assignments 32 h. Lectures 32 h. Self-study 60 h. Total 144 h.
Evaluation	Credit test 40%, practical assignments 60%.
Prerequisites	Knowledge of undergraduate level in the areas of informatics and computer science

B.05	***HARDWARE AND SOFTWARE SUPPORT OF CYBER-PHYSICAL SYSTEMS 4 ECTS cr***
Year and Semester	Year 1 Semester 1
Teacher(s)	Topolskiy Dimitri, Candidate of Technical Sciences, Associate Professor of the Department of Computer Engineering.
Aims	This course focuses students on the development of a systematic approach to solving typical problems in programming cyber-physical systems, increasing the level of automation of technological processes, the use of computer-aided design tools. The student gains basic

	knowledge of the basics of programming microprocessor systems and acquires practical programming skills in solving applied problems.
Content	The course materials provide for the acquisition of practical programming skills of cyber-physical systems and their subsequent effective use by the graduate in their professional activities. Course materials include basic concepts of building microprocessor systems, the development of components of software and hardware complexes of cyber-physical systems, familiarity with the tools and programming technologies of microprocessor systems.
Modes of Study	Lectures 32 h Practical assignments 32 h. Self-study 80 h. Total 144 h
Evaluation	Practical assignments 60%, Credit test 40%.
Prerequisites	Knowledge of undergraduate level in the areas of informatics and computer science

B.06	***MOBILE APPLICATIONS DEVELOPMENT*** ***3 ECTS cr***
Year and Semester	Year 1 Semester 1
Teacher(s)	Alexandra Kirsanov, senior lecturer of the Department of Computer Engineering.
Aims	Theoretical and practical training of students in the development of programs for mobile devices (based on Android and iOS) using various modern programming languages (Java, Javascript, Swift, C #)
Content	Overview of modern mobile devices (Android, iPhone, Windows Phone), mobile application development technologies on these platforms. Programming languages: Java (Android), Swift (iPhone), C # (Windows Phone), cross-platform development tools (Xamarin, React Native, Javascript).
Modes of Study	Lectures 32 h Practical assignments 23 h. Self-study 40 h. Course project 40h Total 144 h
Evaluation	Delivery of the course project good and on time 40%, Credit test 30%, practical assignments 30%.
Prerequisites	Object-oriented CASE technologies, basics of software development techologies

B.07	***MACHINE LEARNING, RECOGNITION AND DECISION MAKING*** ***4 MCTS cr***
Year and Semester	Year 1 Semester 1
Teacher(s)	Vladimir Gudkov, Doctor of Science, Professor of the Department of Computer Engineering
Aims	The student obtains basic knowledge in mainstream areas of image processing, including introduction of image fundamentals, image enhancement in the spatial and frequency domains, restoration, color image processing. The student will know main methods of image morphology processing, segmentation and image description. Upon completion of the course, the student will know fundamentals of image recognition.
Content	The course materials are about image enhancement in the spatial and frequency domains, image restoration, color image processing, segmentation and image description. The course materials conclude with a discussion of the fundamentals of image recognition. Course provides additional support in the form of laboratory project suggestions.
Modes of Study	Lectures 32 h Practical assignments 32 h. Self-study 80 h. Total 144 h
Evaluation	Credit test 40%, practical assignments 60%.
Prerequisites	C or C++ programming language, The Basics of OS Windows, Discrete Math, Mathematical Analysis.

B.08	***INFORMATION SYSTEMS DESIGN MANAGEMENT*** ***3 ECTS cr***
Year and Semester	Year 1 Semester 2
Teacher(s)	Alexandra Kirsanova, senior lecturer of the Department of Computer Engineering
Aims	Mastering the technology of information systems (IS) design and maintenance
Content	IS classification. The domain model as the basis for making architectural decisions for IS. The general scheme of the formation of architectural solutions for IS. The main objects of IS and their key relationships. The main architectural IS design solutions. The life cycle of IS. Entity classes modeling. Workflow simulation (business process logic) controlling the state of objects. Event interaction simulation for the organization of collective work of specialists in the IS environment. Modeling objects of external systems.

Modes of Study	Lectures 32 h Practical assignments 32 h. Self-study 80 h. Course project (self-study) 30 h. Total 144 h
Evaluation	Delivery of the course project good and on time 40% Credit test 30%, practical assignments 30%.
Study Materials	Materials corrected/announced during classes.
Prerequisites	Object-oriented CASE technologies

B.09	***DESIGN OF INTELLIGENT SYSTEMS***	***3 ECTS cr***
Year and Semester	Year 1 Semester 2	
Teacher(s)	Igor Kaftannikov, Candidate of Technical Science, Associate Professor of the Department of Computer Engineering	
Aims	Acquaintance with examples of modern intellectual systems, approaches and methods of their design. The study of knowledge representation	
Content	systems, their use and features. Getting skills to use expert systems. Knowledge representation systems: production systems, semantic models and networks. Ontologies Logical conclusions. Unsophisticated reasoning and their presentation. Design of intelligent systems (decision support, expert systems). Elements of situational management.	
Modes of Study	Lectures 24 h Practical assignments 24h. Self-study 60 h. Total 108 h	
Evaluation	Practical assignments 60%, Credit test 40%.	
Prerequisites	Knowledge of undergraduate level in the areas of informatics and computer science	

B.10	***INTERNET OF THINGS TECHNOLOGY AND PLATFORMS***	***4 ECTS cr***
Year and Semester	Year 1 Semester 2	
Teacher(s)	Igor Kaftannikov, Candidate of Technical Science, Associate Professor of the Department of Computer Engineering	

Aims	Familiarity with the properties and features of the application of the Internet of things. Study of modern systems and components of support and provision of Internet of things technologies and embedded systems. Obtaining skills of transformation of functional requirements into technical implementation of cyber-physical systems.
Content	Acquaintance with the structures and properties of the subject areas of the Internet of things: production, business, social sphere. The study of modern systems, components and properties of support and provision of Internet of things technologies, such as "Smart home", "Smart management", "Smart services" , etc. The use of embedded objects and systems in these areas. Skills-transformation of functional requirements into a technical implementation of cyber-physical systems.
Modes of Study	Lectures 32 h Practical assignments 32h. Self-study 80 h. Total 144 h
Evaluation	Practical assignments 60%, Credit test 40%.
Prerequisites	Knowledge of undergraduate level in the areas of informatics and computer science

B.11	***DISTRIBUTED COMPUTING SYSTEMS 3 ECTS cr***
Year and Semester	Year 1 Semester 2
Teacher(s)	Gleb Radchenko, Candidate of Science, head of the Department of Computer Engineering.
Aims	The student obtains basic skills in distributed computing systems and service-oriented architectures. Upon completion of the course, the student will be able to design and implement distributed applications based on RMI, web-services and cloud computing approach.
Content	Definition, classification and history of Distributed Computing Systems. The CAP theorem. RMI and distributed object technologies middleware approaches: RPC, RMI, Message Queues, Multilayer Client-Server Architecture. Service Oriented Architecture: definition, basic concepts, good practices. SOA architecture approaches: RPC services (JSON RPC, GRPC, XML Web Services); REST; Graph API. Principles and technology of peer-to-peer systems. Virtualization and Containerization technologies. Cloud computing technologies and platforms.

Modes of Study	Practical assignments 16 h. Lectures 32 h. Self-study 60 h. Total 108 h.
Evaluation	Credit test 40%, practical assignments 60%.
Prerequisites	Knowledge of undergraduate level in the areas of informatics and computer science

B.12	***CYBERPHYSICAL SYSTEMS***	***3 ECTS cr***
Year and Semester	Year 1 Semester 2	
Teacher(s)	Natalya Plotnikova, Candidate of Science, Associate Professor of Automatic Control Systems Department	
Aims	The student obtains basic skills in the robotics sphere. Upon completion of the course the student will be able to analyze a structure of cyberphysical system, understand the device of robots, know the principles of robotics control, acquire and apply the main knowledge concerning kinematics and dynamics of such systems, get acquainted with the main scopes and current trends of development of cyberphysical system.	
Content	History of robotics. Main terms and definitions. Industrial robots and their classification. Structure and device of industrial robots. Main technical characteristics. Drives of industrial robots. Information systems of robots. Gripping devices of industrial robots. Control systems of robots. Adaptive and intelligent robots. Kinematics and dynamics of manipulators. Design of industrial robots. Application of robotics in the industry. Recent trends and developments in robotics.	
Modes of Study	Lectures 32 h Practical assignments 32 h. Self-study 80 h. Total 144 h.	
Evaluation	Delivery of the semestrial task good and on time 50 %, Credit test 25%, practical assignments 25%.	
Prerequisites	Mathematics, theoretical mechanics	

B.13	***DATA MINING AND BIG DATA PROCESSING***	***4 ECTS cr***
Year and Semester	Year 1 Semester 2	
Teacher(s)	Mikhail Zymbler, Candidate of Science, Associate Professor of System Programming Department.	

Aims	The student obtains basic knowledge in Data Mining. Upon completion of the course, the students will be able to use KNIME software package to solve typical problems of Data Mining.
Content	Data Mining as a process of Knowledge Discovery. Data Warehouses and OLAP. Basic tasks of Data Mining: association rule mining, classification, clustering. Basic methods for frequent itemset mining (Apriori, ECLAT, etc.). Evaluations measures of association rules (support, confidence, lift). Basic methods of classification (decision trees, classification by nearest neighbors, etc.). Evaluations measures of classification (precision, recall, F1 score, etc.). Basic methods of clustering (partitioning, hierarchical, and fuzzy clustering, etc.). Evaluations measures of clustering (Silhouette coefficient).
Modes of Study	Lectures 32 h Practical assignments 32 h. Self-study 80 h. Total 144 h
Evaluation	Practical assignments 60%, Credit test 40%.
Prerequisites	Knowledge of undergraduate level in the areas of informatics and computer science

B.14	***CLOUD COMPUTING TECHNOLOGIES 4 ECTS cr***
Year and Semester	Year 2 Semester 1
Teacher(s)	Gleb Radchenko, Candidate of Science, head of the Department of Computer Engineering.
Aims	The purpose of the discipline is to study the basic concepts of cloud architecture, as well as methods of developing applications for cloud systems.
Content	The history and the concept of Cloud computing. The architecture of cloud computing systems, levels of cloud services (Infrastructure-as-a-Service, Platform-as-a-Service, Software-as-a-Service). The architecture of private and public cloud systems. Main virtualization and containerization technologies. Docker platform. Cloud services orchestration (Docker Swarm, Kubernetes). Microservice architecture, methods and approaches of cloud applications design.
Modes of Study	Practical assignments 32 h. Lectures 32 h. Self-study 80 h. Total 144 h.
Evaluation	Credit test 40%, practical assignments 60%.
Prerequisites	Knowledge of distributed computing systems design and implementation

B.15	*LEGAL AND ETHICAL ISSUES IOT* *3 ECTS cr*
Year and Semester	Year 2 Semester 1
Teacher(s)	Vlada Zhernova, Candidate of Law Science, Associate Professor of Information Security Department
Aims	The student obtains basic knowledge in sphere of Internet of Things legal regulation. Upon completion of the course, the student will know main legal acts by different countries which regulate development and application area of Internet of Things.
Content	Law enforcement issues in the field of the Internet of Things. Legislation of various countries governing the use of smart devices. Ethical issues in the development and use of the Internet thing. Approaches of various countries to use elements of the Internet of things in the human world.
Modes of Study	Lectures 32 h Practical assignments 16 h. Self-study 60 h. Total 108 h
Evaluation	Credit test 40%, practical assignments 60%.
Prerequisites	Understanding of the concept of the internet of things.

B.16	*CYBERSECURITY OF THE INTERNET OF THINGS* *3 ECTS cr*
Year and Semester	Year 2 Semester 1
Teacher(s)	Vasiliy Luzhnov, Senior Lecturer of Information Security Department
Aims	Following the course, students will be able to: - Demonstrate understanding of IoT cybersecurity concepts - Develop an IoT cybersecurity roadmap – a step-by-step approach to reach IoT security goals - Describe how cybersecurity incident response and mitigation work on practice - Demonstrate confidence and knowledge of IoT cybersecurity models.
Content	General principles of cybersecurity. Potential positive impacts of IoT, the tradeoff of ROI and security. IoT Cyber Security Concerns. IoT security requirements. Barriers to adoption of IoT, including security, data control, and access, shared standards, safety, and privacy. Corporate IoT security posture, IoT security leaders. IoT assets and cybersecurity objectives, common IoT attacks, threats, and vulnerabilities. Incidents and mitigation strategies, prevention relative to devices, gateways and cloud or apps. Disaster recovery and business continuity plans, roles and

	responsibilities, escalation procedures, achieving cyber resilience, compliance. Absence of a standard reference architecture, competition of reference models, common basic model, OSI stack, emerging models.
Modes of Study	Lectures 32 h Practical assignments 32 h. Self-study 80 h. Total 144 h
Evaluation	Credit test 40%, practical assignments 60%.
Prerequisites	Understanding of the fundamentals of IT, basic concepts of IoT Networks

B.18	***SENSORS AND SENSOR NETWORKS FOR THE INTERNET OF THINGS*** ***3 ECTS cr***
Year and Semester	Year 2 Semester 1
Teacher(s)	Ekaterina Yurasova, Candidate of Science, Associate Professor of Informational and Measuring Technology Department
Aims	The student obtains basic skills in design and administration of wireless sensor networks. Upon completion of the course, the student will be able to use of automation tools for measuring information exchange with intelligent sensors using IEEE 802.15.4 – ZigBee, Wireless HART protocols.
Content	DAC and ADC solutions for various physical quantities Design construction of digital sensors Fundamentals of data transmission in wireless sensor networks. Extended-spectrum technology. Methods of access to the environment in wireless networks. Coding and error protection. The architecture of the sensor network: IEEE 802.15.4. ZigBee network devices: ZigBee Coordinator; ZigBee Router; ZigBee End device. Heterogeneous ZigBee networks. Self-organizing wireless sensor network based on IEC 62591 WirelessHART standard. Self-organizing adaptive mesh network routing.
Modes of Study	Lectures 32 h Practical assignments 16 h. Self-study 60 h. Total 108 h
Evaluation	Laboratory work at the university good and on time 40%, Credit test 30%, practical assignments 30%.
Prerequisites	Basic skills in Metrology and Networking Technology

B.19	***CASE RECOGNITION AND DECISION-MAKING***	***3 ECTS cr***
Year and Semester	Year 2 Semester 1	
Teacher(s)	Igor Kaftannikov, Candidate of Technical Science, Associate Professor of the Department of Computer Engineering	
Aims	Familiarity with the objects and principles of situational management. The study of models of situational recognition and control. Mastering the methods of practical application of situational decision making	
Content	Principles of situational management. Unconventional objects. States and situations. Languages describing objects and situations. Semiotic models. Updating situations. Generalization and description of situations. Formation and extrapolation of solutions	
Modes of Study	Lectures 24 h Practical assignments 24h. Self-study 60 h. Total 108 h	
Evaluation	Practical assignments 60%, Credit test 40%	
Prerequisites	Knowledge of undergraduate level in the areas of informatics and computer science	