Ministry of Science and Higher Education of the Russian Federation
NATIONAL RESEARCH
TOMSK STATE UNIVERSITY (NR TSU)

Faculty of Innovation technologies

УТВЕРЖДАЮ:
Декан
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Annotations of work programs for disciplines and for internship work programs

Educational program/ Code of study
09.04.02 Information systems and technologies

Specialization/ Profile of study:
Computer Engineering: Applied Al and Robotics

Learning mode
Full-time

Qualification
Master

Year of admission
2022

Tomsk – 2022

Б1.О.01 Professional communication in a foreign language

Compulsory discipline.
1st semester, credit.
2nd semester, exam.
Language of instruction – English.
The total workload of the discipline is 5 credit units; 180 hours, including 50 hours of practical classes.

Course outline:

Topic 1. Food in everyday and global context.
Reading: searching for detailed information, highlighting the general meaning;
Listening: searching for detailed information, highlighting the general meaning;
Writing: writing a review reflecting the author's opinion;
Speaking: monologue on a given topic, answering questions;
Vocabulary: food, restaurants, diet, description of trends, advantages and disadvantages
Academic skills: giving your own opinion and reasoning.

Topic 2. Financial literacy.
Reading: highlighting the general meaning; infer the main idea of the text while reading.
Listening: searching for detailed information, infer the meaning from the context;
Writing: writing an email;
Speaking: monologue - description, engaging in conversations;
Vocabulary: finance, financial literacy, income and expenses, Internet technologies in the financial sector.
Academic skills: reporting about problems.

Topic 3. People and society.
Reading: highlighting the general meaning; summarizing.
Listening: working with key words, understanding the main idea;
Writing: writing an essay;
Speaking: discussion, answering questions, reporting the results of scientific research;
Vocabulary: interpersonal relationship.
Academic skills: literature review, writing abstracts and summaries.

Topic 4. Transport.
Reading: searching for detailed information, highlighting the general meaning;
Listening: infer the meaning from the context;
Writing: comparing two or more objects (objects/phenomena, etc.) on the topic of students' professional activity;
Speaking: dialogue-questioning;
Vocabulary: transport links in the city, driving directions;
Academic skills: comparing and contrasting.

Topic 5. Work and labor relations in the company.
Reading: searching for detailed information, highlighting the general meaning;
Listening: working with key words, understanding the main idea;
Writing: writing a CV;
Speaking: dialogue-questioning;
Vocabulary: business English;
Academic skills: job interview.

Topic 6. The Internet.
Reading: searching for detailed information, highlighting the general meaning;

Listening: working with key words, logical coherence;
Writing: description of a graph;
Speaking: explaining data presented in the table, on the graph;
Vocabulary: The Internet and modern technologies;
Academic skills: analysis of graphic information, description of data presented in the table, on the graph.

Topic 7. Education. World Leading Universities.
Reading: searching for detailed information, highlighting the general meaning;
Listening: working with key words, logical coherence;
Writing: writing abstracts to papers;
Speaking: explaining data presented in the table, on the graph;
Vocabulary: university education, description of the academic process;
Academic skills: paper review, preparing a scientific report.

Б1.О.02 Системное и критическое мышление*Systems and critical thinking

Compulsory discipline.
First semester, credit.
Language of instruction - English.
The total workload of the discipline is 3 credit units, 108 hours, including: 6 hours of lectures and 18 hours of practical classes.

Course description
1 Introduction
The course introduces students to the basics of systems and critical thinking, including the study of general systems theory and critical thinking skills. Through the presentation of theoretical and practical considerations, this syllabus is designed to illustrate how the contribution of systems and critical thinking lies precisely in giving reflexive evaluation to how people, as individuals and societies, deal with rationality and cognitive biases. Thus, studying systems and critical thinking strengthens the development of a deeper reflection on theoretical and practical issues in everyday as well as professional life.
2 Aims and objectives
The course in systems and critical thinking will enable students to:
a) gain knowledge and understanding of systems thinking through consideration of some important academic issues and approaches to problems;
b) develop a rigorous approach, both critical and constructive, to the study of general systems theory;
c) practice and enhance their abilities to construct, develop, and maintain clear and coherent arguments;
d) acquire skills in comprehension, interpretation, analysis, and evaluation that facilitate the development of independent thinking based on a critical examination of the evidence and rational argumentation. These skills are applicable in the study of other academic subjects and in reflection on other important aspects of human experience.
Based on the above aims, students should be able to:
a) define and describe the main aspects of systems thinking;
b) identify critical and constructive concerns of the general systems theory;
c) present well-structured and logically sound arguments in oral form;
d) show thorough knowledge of the selected extracts and take a critical stance where necessary.
3 Content
The course has three modules.

Module 1. Systems theory and practice

1.1. *Defining systems.* Components and relationships. Adaptiveness and changeability. Inputs from the environment. Networked structure. Levels of autonomy and constraints. Characteristics of systems. Purpose as a property of the system. Feedback loops and stability of the system. Flow of information.

1.2. *Systems thinking*. Perspective and outlook. How and why things work. Language of systems. Reductionist approach. Traditional analysis and systems thinking. Analysis and synthesis. Holistic thinking. Linear and systems thinking: causality, time, responsibility, strategy. Systems thinking foundations. Applied systems analysis.

Module 2. Introduction to critical thinking

2.1. *Critical thinking: standards, benefits, and barriers.* Clarity. Precision. Accuracy. Relevance. Consistency. Logical correctness. Completeness. Fairness. Critical thinking in the classroom, workspace, and life. Egocentrism. Sociocentrism. Unwarranted assumptions and stereotypes. Relativistic and wishful thinking.

2.2. *Reason, cognitive biases, and critical reflection.* The brain is an inference machine. Representation as projection. Emotions and reason: homeostasis and allostasis. Overcoming cognitive biases. Critical reflection and metacognition. Confirmation and anchoring biases. Availability heuristic. Tribalism. Bandwagon fallacy.

Module 3. **Presenting and discussing a topic**

You need to choose the most preferable topic, read or watch relevant material from the list of resources, and present the topic at one of the seminars in a 40-minute talk with answers to questions.

Б1.О.03 Leadership and Teamwork Management

Compulsory discipline.
Second semester, credit.
Language of instruction - English.
The total workload of the discipline is 3 credit units, 108 hours, including: 6 hours of lectures and 18 hours of practical classes.

Course outline:

Topic 1. Nature and qualities of a leader. Distinction from a manager. Qualities of both statuses. Can anyone be a leader?

Topic 2. Types of managers and leaders. Specifics of behavior, styles, and the revelation of the value aspect. Ethics of leadership.

Topic 3. Theoretical approaches and concepts of team management and leadership. Features of the synthetic approach.

Topic 4. Team management mechanisms. Common mistakes and recommendations for their elimination, working with case studies.

Topic 5. Specifics of leadership in different cultures.

Topic 6. Business culture and points of contact with communication between different types of organizations.

Topic 7. Work on the development and personal growth of the leader and their subordinates. Topic 8. Final cases, moderation, group work, and decision-making.

Б1.О.04 Technologies of self-organization and intercultural interaction

Compulsory discipline for study.
First semester, credit.
Language of instruction - English.

The total workload of the discipline is 3 credits, 108 hours, including: 6 hours of lectures and 18 hours of practical classes.

Course outline:

Topic 1. Self-organization as the basis of personal self-development. Key theories of personality development. Self-actualization as the highest form and result of self-organization.

Topic 2. Technologies of self-organization. Self-awareness. Self-management techniques. Planning. Organization. Motivation. Control.

Topic 3. Intercultural interaction. Issues in intercultural interaction. The significance and value of "I," the complexity and contradictions in the interaction between "I" and "YOU"; the relationship between language and mind. Ethics of intercultural communication. Understanding the principles of intercultural interaction, recognizing different values and beliefs. Extraversion and introversion as ways of interacting with the world. Temperament and its role in professional communication.

Topic 4. Communication technologies in the context of intercultural interaction. Contact establishment techniques. Questioning techniques. Active listening techniques. Argumentation techniques and handling objections. Kinesics as a non-verbal communication technique in intercultural interaction."

Б1.О.05 Project management strategies and technologies

Compulsory discipline.

First semester, graded credit.

Language of instruction - English.

The total workload of the discipline is 4 credits, 144 hours, including: 10 hours of lectures and 20 hours of practical classes.

Course outline:

Topic 1. General Provisions. Innovative projects in the field of software development and projects. Specifics, classification, participating entities. Justification of significance and feasibility. Formulation of optimal solutions for creating new knowledge-intensive products, considering quality, cost, deadlines, competitiveness, and environmental safety requirements. Resource constraints in project activities and their impact on goal setting. Principles, tasks, and criteria for the effectiveness of work in the development of software and projects.

Topic 2. General Approaches to Innovation Project Management. Management specifics. Functions of leaders and participants. Psychological foundations of managing innovation processes. Leadership, leadership, team formation. Motivation system. Conflict management. Control and regulation. Purpose and purpose of control. Control methods. Assessment of work status and forecasting of changes. Change management technology. Labor standardization. Definition of operations, their sequence and interrelation. Development of an innovation project schedule. Network models. Adjusting the network schedule. Schedule management. Tools for project development. Project management strategies.

Topic 3. Management of Resources for Innovation Processes. Hierarchical work structure. Calendar project planning. Planning, organization, and execution of the project within the customer's approved requirements, budget, and deadlines. Schedule management. Identification of time reserves. Basic principles of cost management. Types of estimates and their development procedure. Cost estimation. Budgeting. The method of earned value. Cost reporting. Approaches to assessing the economic potential of innovation, expenses for the implementation of research projects. Communication planning. Information dissemination. Reporting on execution. Acceptance and handover management of the project. Approaches to monitoring and analyzing deviations for the effective achievement of project goals within the customer's approved requirements, budget, and deadlines.

Б1.О.06 Mathematical foundations of information systems

Compulsory discipline.

First semester, graded credit.

Language of instruction - English.

The total workload of the discipline is 3 credits, 108 hours, including 6 hours of lectures and 20 hours of practical classes.

Course outline:

Topic 1. Introduction. Introduction to dynamic systems and control systems (CS).

Topic 2. Mathematical Models of Systems. Description of physical systems with differential equations. Transient process of the system. Assessment of the performance quality of the control system. Objectives functions. Laplace, Fourier, Carson-Heaviside transformations. Transfer functions.

Topic 3. CS Models in State Variables. Concept of state space for describing dynamic systems.

Topic 4. CS under Random Influences. Basic concepts. Random processes. Kalman filter and its application areas. 2D Kalman filter."

Б1.О.07 Intelligent analysis of big data

Compulsory discipline.

First semester, graded credit.

Language of instruction - English.

The total workload of the discipline is 5 credits, 180 hours, including: 12 hours of lectures and 28 hours of practical classes.

Course outline:

Topic 1. Big Data (Introduction).

Concept of big data. Big data in business. Sources of big data. Big data challenges.

Topic 2. Big Data Analysis Techniques.

Big Data Analysis Techniques. Visualization of big data. Big data visualization services.

Topic 3. Big Data Tools.

Hadoop Apache. Working with the Cloudera virtual machine.

Topic 4. Big Data Storage and Processing Technologies.

Data storage technologies. Data processing technologies. HDFS file system.

Topic 5. Hadoop Computing Core.

MapReduce. YARN. Solving MapReduce tasks.

Topic 6. Pig Scripts.

High-level platform. Using the Pig computational mechanism.

Topic 7. Hadoop Databases.

Hadoop SQL and NoSQL databases. SQL Hive tool.

Topic 8. Data Lake.

Data Lake. Corporate storage.

Б1.О.08 System simulation

Compulsory discipline.

Second semester, graded credit.

Language of instruction - English.

The total workload of the discipline is 3 credits, 108 hours, including 6 hours of lectures and 20 hours of laboratory classes.

Course outline:

Lectures:

Topic 1. Classification of models and types of modeling. Stages of mathematical modeling. Principles of construction and basic requirements for mathematical models of systems.

Topic 2. Typical schemes of mathematical modeling: Mathematical schemes. Formal model of an object. Continuous-deterministic models (D-schemes). Discrete-deterministic models (F-schemes). Discrete-stochastic models (P-schemes). Continuous-stochastic models (Q-schemes). Network models (N-schemes). Combined models (A-schemes).

Topic 3. Statistical modeling. Modeling languages. Simulation modeling. Modeling of control systems.

Laboratory work:

Laboratory Work 1. Building simulation models of dynamic systems.

Laboratory Work 2. Numerical integration of single-variable functions.

Laboratory Work 3. Building discrete-deterministic models.

Laboratory Work 4. Simulation modeling of dynamic modes of automatic control systems with concentrated parameters.

Laboratory Work 5. Simulation modeling of nonlinear systems. Automatic control systems with variable structure.

Б1.О.09 System engineering

Compulsory discipline.

Second semester, credit.

Language of instruction - English.

The total workload of the discipline is 2 credits, 72 hours, including: 6 hours of lectures and 20 hours of laboratory classes.

Course Outline:

Section 1. Introduction to Systems Engineering. Fundamental concepts of systems engineering. Basic concepts and terminology. System lifecycle. The role and tasks of systems engineering. Requirements analysis. Requirements and needs. Stakeholders. Risk management. Systematic approach and systems thinking. Development process of complex systems. Key methods for analyzing and designing complex systems. Architectural design.

Section 2. Methods and Practices of Systems Engineering. Methods and practices of systems engineering in the field of information systems development. Modeling complex systems. UML. SysML. IDEF. CASE tools. Software for systems engineering of information systems.

Б1.О.10 Distributed computing technologies

Compulsory discipline.

Second semester, credit.

Language of instruction - English.

The total workload of the discipline is 2 credits, 72 hours, including: 6 hours of lectures and 20 hours of practical classes.

Course Outline:

Topic 1. Parallel Computing Systems.

Architecture and software of high-performance computing systems. Parallel programming technologies.

Topic 2. C# Programming.

Basic constructs of the C# language. Working with arrays. Using Threads.

Б1.О.11 Automation of technology processes

Compulsory discipline.

First semester, exam.

Language of instruction - English.

The total workload of the discipline is 6 credits, 216 hours, including: 12 hours of lectures, 20 hours of practical classes and 20 hours of laboratory classes.

Course Outline:

Topic 1. Introduction to Automation.

General information, structural diagram of ACS (Automated Control Systems for Technological Processes). Stages of ACS development (GOST 34.601-90). Study of educational material and thematic publications.

Topic 2. Elements of ACS.

Microprocessor-based automation tools. Sensors and actuators. Industrial networks. SCADA. Building three conveyors in the Factory I/O simulation environment using all modes of conveyor belt control. Using a logical controller programming language to build a sorting/assembly conveyor (optional) in the Factory I/O simulation environment. Creating a 3D environment in the KUKA Sim PRO simulation environment relative to a real object. Interaction of KUKA robotic arm with 3D objects built in the KUKA Sim Pro simulation environment. Implementation of an algorithm for interacting with 3D objects on a real KUKA robotic arm manipulator.

Б1.О.12 Methodology for solving scientific, technical and social problems

Compulsory discipline.

First semester, graded credit.

Language of instruction - English.

The total workload of the discipline is 3 credits, 108 hours, including: 6 hours of lectures and 20 hours of practical classes.

Course Outline:

Topic 1. Purposeful Activity as the Basis for Systematizing Tasks.

Structure and composition of Purposeful Systematic Activity (PSA). PSA representation in design. Problem situation. Creative task. Linear model of the knowledge life cycle: differences between fundamental and applied research, the case of antibiotics, differences between technological and incremental or user innovations.

Topic 2. Classification of Tasks.

Approaches to task classification: catalog, typological, theoretical. The model of an open system in cybernetics and task classification according to V.Ya. Bush. Task classification based on the linear model of the knowledge life cycle. PSA classification of tasks. Cognitive and pragmatic tasks in PSA representation. Classification of hypothesis formulation tasks. Heuristics for hypothesis formulation. Classification of search tasks.

Topic 3. Pragmatic Tasks. Specifics of pragmatic tasks. The operating principle of V.I. Korogodin's Purposeful System as a source of heuristics for crisis analysis. Case on marketing tasks. Source of incremental and marketing innovations.

Topic 4. Heuristics for Working with Target Elements.

Eighteen heuristics for working with target elements with case studies.

Б1.О.13 Academic seminar

Compulsory discipline.

Second semester, credit.

Third semester, graded credit.

Language of instruction - English.

The total workload of the discipline is 4 credits, 144 hours, including: 16 hours of lectures.

Course Outline:

Introduction to Scientific Research.

The section considers the concepts of the object and subject of research, understanding the current state of research in the field through the study of global citation databases of scientific publications, and the acquisition of basic skills for the correct interpretation of the results of scientific research.

The section includes the following topics:

1.1. Algorithm of scientific research, definition of the research theme.

1.2. Analysis of the current state in the research area, problem statement, and strategies for its solution.

1.3. Program and methods of experimental research.

1.4. Preparation of scientific publications and Master's thesis.

Б1.О.14 Technology management

Compulsory discipline.

Third semester, graded credit.

Language of instruction - English.

The total workload of the discipline is 3 credits, 108 hours, including 6 hours of lectures and 20 hours of practical classes.

Course Outline:

Lecture Topics:

Section 1. Basic Concepts of Technological Management. Essence, objectives, tasks, and functions of technological management.

Lecture 1. Basic Concepts of Technological Management. Essence, objectives, tasks, and functions of technological management.

Section 2. Fundamentals of Managing Production and Technological Processes.

Lecture 2. Strategic Analysis of Technologies.

Lecture 3. Innovation Implementation.

Practical Class Topics:

1. Technological Development and Competitive Advantages.

2. Planning as a Component of Technological Management.

3. Enterprise as an Object of Technological Management. Composition and interrelation of production factors. The concept of the production and technological process.

4. Composition of the technological process by technological feature: main production, auxiliary production, servicing production, ancillary and by-product production.

5. Concept of the production structure of the enterprise. Factors determining the production structure of the enterprise. Elements of the production structure of the enterprise: workstations, sections, workshops.

6. Forms of organizing the technological process in time and space. The temporal structure of production organization forms: with sequential, parallel, and sequential-parallel transfer of work items.

7. Types of production capacity: maximum, project, input, output, and average.

8. Efficiency of technological management.

9. Production capacity of the enterprise. Quality management of products.

10. Concepts of economic effect and economic efficiency.

Б1.В.01 System design

Compulsory discipline.

Second semester, credit.

Third semester, exam.

Language of instruction - English.

The total workload of the discipline is 7 credits, 252 hours, including: 6 hours of lectures and 40 hours of practical classes.

Course Outline:

Topic 1. Fundamental Concepts, Design Stages, Requirements of Regulatory Documentation.

Systematic approach to design. Design stages. Regulatory documentation governing the presentation of design solutions (GOST 34.201-2020, GOST R 59793–2021, GOST R 59795–2021, GOST 21.208-2013, GOST 21.110-2013, etc.). Types of provisions and the composition of documentation for automated systems (technical, informational, mathematical, software, cross-system solutions).

Topic 2. Technical Support.

Key schematic solutions for technical support (structural scheme of the complex of technical means, functional automation scheme, electrical schematic diagrams, connection and attachment diagrams). Requirements for specifying specifications.

Topic 3. Software.

Composition of software documents. Key paradigms of software development (procedural, structural, aspect-oriented, object-oriented, functional, logical, etc.). Choice of programming language. Object-oriented programming, basic principles.

Topic 4. Information Support. Fundamental concepts of information support (off-machine and on-machine databases, data flows, system architecture), methods of presenting information support, development of information support schemes based on the Unified Modeling Language (UML), an overview of key design patterns when developing information and software, user interfaces, situational perception methods, ergonomic requirements.

Topic 5. Mathematical Support. Types of documents. Methods for presenting algorithms.

Topic 6. Organizational Support. Types of users, user authentication and identification. Key requirements for user manuals development.

Б1.В.02 Theory of control systems

Compulsory discipline.

First semester, exam.

Language of instruction - English.

The total workload of the discipline is 4 credits, 144 hours, including: 6 hours of lectures and 20 hours of practical classes.

Course Outline:

Topic 1. Automatic Control Systems.

Concept of control, control objectives, control object, automatic control system, closed-loop system, feedback. Tasks of control theory.

Topic 2. Identification of Dynamic Systems.

Transient processes and basic methods of identification of control objects.

Topic 3. Frequency Characteristics.

Concept of frequency characteristics. Frequency transfer function. Bode plots, Nyquist plots, amplitude-frequency characteristics.

Topic 4. Stability of Control Systems.

Analysis of the main properties of linear control systems: stability, invariance, sensitivity, controllability, and observability. Conditions for the stability of automatic control systems. Frequency stability criteria.

Topic 5. Synthesis of Automatic Control Systems.

Basics of parametric synthesis of control systems. Concept of regulation, typical control laws. Assessment of regulation quality in steady-state modes. Synthesis of an automatic control system with typical control laws.

Topic 6. Intelligent Control Systems.

Concept and classification of adaptive systems. Systems with parametric adaptation. Systems with structural adaptation. Self-learning systems. Synthesis of a control system based on fuzzy logic theory. Synthesis of a control system based on neural network technology.

Б1.В.03 AI and machine learning

Compulsory discipline.

Second semester, exam.

Language of instruction - English.

The total workload of the discipline is 5 credits, 180 hours, including: 12 hours of lectures; 20 hours of laboratory work and 20 hours of practical classes.

Course Outline:

Lectures:

Topic 1. Artificial Intelligence. Includes an introduction to artificial intelligence, examination of basic terminology, application areas, and an overview of artificial intelligence technologies.

Topic 2. Machine Learning. Includes an introduction to machine learning, examination of basic terminology, and core machine learning technologies. Emphasis is placed on the concept of artificial neural networks, mathematical models of neural networks, and key tasks solved using machine learning algorithms.

Practical classes:

1. Building mathematical regression models.
2. Structural diagram of intelligent agent control.
3. Building a mathematical model of a fully connected neural network.
4. Building a mathematical model of a convolutional neural network.

Laboratory work:

1. Implementation of a machine learning regression model.
2. Working with datasets and data annotation.
3. Solving classification problems using neural networks.
4. Solving clustering problems.

В1.В.ДВ.01.01.01 Vision Systems

Elective discipline.

The discipline is part of the 'Russian Language Module.'

Third semester, graded credit.

Language of instruction - Russian.

The total workload of the discipline is 5 credits, 180 hours, including: 6 hours of lectures and 20 hours of laboratory work.

Course Outline:

Topic 1. Introduction to Computer Vision.

The section covers the fundamental concepts of computer vision theory as well as modern methods and approaches.

Topic 2. Images and Sensors.

The section focuses on the mathematical model of images and color spaces as well as technologies for obtaining images using photosensors.

Topic 3. Image Processing and Pattern Recognition Algorithms.

The section examines basic algorithms and methods.

Topic 4. Image Processing with Python.

The section explores a set of libraries and the application of the Python programming language in digital image processing.

Topic 5. Facial Landmark Detection.

The section discusses methods for detecting facial landmarks on images as well as commonly used detectors.

Topic 6. Face Detection Using Neural Networks.

The section covers the algorithm for face detection using neural networks.

Topic 7. Image Recognition in Video Sequences.

The section examines algorithms for working with frame sequences.

Topic 8. Generative Adversarial Networks.

The section focuses on the concept of generative adversarial networks and their applications.

Б1.В.ДВ.01.01.02 Navigation Systems

Elective discipline.

The discipline is part of the 'Russian Language Module.'

Third semester, graded credit.

Language of instruction - Russian.

The total workload of the discipline is 5 credits, 180 hours, including: 6 hours of lectures and 20 hours of laboratory work.

Course Outline:

Topic 1. Introduction to Navigation Systems.

Basic navigation mathematical methods. Coordinate systems. Coordinate transformations. Earth's geometry. Types of coordinates in the geocentric system. Gravity. ROS: Local Coordinate System.

Topic 2. Global Navigation Satellite Systems.

GPS. GLONASS. COMPASS. Accuracy reduction. Conversion of Quaternions to Euler angles.

Topic 3. Visual Navigation. Visual odometry. Motion estimation (2D, 3D). PNP solver. Autonomous navigation of a mobile robot.

Б1.В.ДВ.01.01.03 Embedded Systems

Elective discipline.

The discipline is part of the 'Russian Language Module.'

Third semester, graded credit.

Language of instruction - Russian.

The total workload of the discipline is 5 credits, 180 hours, including: 6 hours of lectures and 20 hours of laboratory work.

Course Outline:

Topic 1. Microprocessors and Microcontrollers.

Introduction to embedded systems. Applications of embedded systems. Introduction to computer architectures - Von Neumann and Harvard Architectures. Computer architecture: Microprocessors and microcontrollers. Intel 8051 and 8056. Introduction to Arduino and its derivatives. Introduction to Autodesk Tinkercad. Application of actuating mechanisms. Sensor applications. Integration of sensors and actuating mechanisms.

Topic 2. Computer Architecture.

Computer architecture: Processor instruction sets; Pipeline processing; Modern microprocessors. Modern applications of embedded systems. IoT. Timers and PWM. Introduction to Raspberry Pi. Embedded Python. Platforms for network-based Raspberry Pi control.

Topic 3. Parallel Computing Architecture Devices.

FPGAs. SystemVerilog. Introduction to Intel Quartus, Modelsim, and SystemVerilog. FPGA design."

Б1.В.ДВ.01.02.01 Vision Systems

Elective Discipline.

The discipline is part of the 'English Language Module.'

Third semester, graded credit.

Language of instruction - English.

The total workload of the discipline is 5 credits, 180 hours, including: 6 hours of lectures and 20 hours of laboratory work.

Course Outline:

Topic 1. The Concept of Computer Vision.

The section explores the fundamental concepts of computer vision theory as well as modern methods and approaches.

Topic 2. Image and Sensors.

The section explores the mathematical model of images, color spaces, and technologies for capturing images using photosensors.

Topic 3. Image Processing and Pattern Recognition Algorithms.

The section discusses basic algorithms and methods.

Topic 4. Image Processing with Python.

The section discusses a set of libraries and the possibilities of using the Python programming language in digital image processing.

Topic 5. Facial Landmark Detection.

The section discusses methods for locating facial landmarks on images and the main detectors used.

Topic 6. Facial Detection Using Neural Networks.

The section examines an algorithm for facial detection using neural networks.

Topic 7. Image Recognition in Video Sequences.

The section discusses algorithms for working with frame sequences.

Topic 8. Generative Adversarial Networks (GANs).

The section discusses the concept of Generative Adversarial Networks and their application areas.

Б1.В.ДВ.01.02.02 Navigation Systems

Elective discipline.

The discipline is part of the 'English Language Module.'

Third semester, graded credit.

Language of instruction - Russian.

The total workload of the discipline is 5 credits, 180 hours, including: 6 hours of lectures and 20 hours of laboratory work.

Course Outline:

Topic 1. Introduction to Navigation Systems.

Basic navigation mathematical methods. Coordinate systems. Coordinate transformations. Earth's geometry. Types of coordinates in the geocentric system. Gravity. ROS: Local Coordinate System.

Topic 2. Global Navigation Satellite Systems.

GPS. GLONASS. COMPASS. Accuracy reduction. Conversion of Quaternions to Euler angles.

Topic 3. Visual Navigation. Visual odometry. Motion estimation (2D, 3D). PNP solver. Autonomous navigation of a mobile robot.

Б1.В.ДВ.01.02.03 Embedded Systems

Elective discipline.

The discipline is part of the 'English Language Module.'

Third semester, graded credit.

Language of instruction - Russian.

The total workload of the discipline is 5 credits, 180 hours, including: 6 hours of lectures and 20 hours of laboratory work.

Course Outline:

Topic 1. Microprocessors and Microcontrollers.

Introduction to embedded systems. Applications of embedded systems. Introduction to computer architectures - Von Neumann and Harvard Architectures. Computer architecture: Microprocessors and microcontrollers. Intel 8051 and 8056. Introduction to Arduino and its derivatives. Introduction to Autodesk Tinkercad. Application of actuating mechanisms. Sensor applications. Integration of sensors and actuating mechanisms.

Topic 2. Computer Architecture.

Computer architecture: Processor instruction sets; Pipeline processing; Modern microprocessors. Modern applications of embedded systems. IoT. Timers and PWM. Introduction to Raspberry Pi. Embedded Python. Platforms for network-based Raspberry Pi control.

Topic 3. Parallel Computing Architecture Devices.

FPGAs. SystemVerilog. Introduction to Intel Quartus, Modelsim, and SystemVerilog. FPGA design.

Б1.В.ДВ.02.01 Fundamentals of Experimental Theory

Elective discipline.

Third semester, credit.

Language of instruction - English.

The total workload of the discipline is 3 credits, 108 hours, including: 6 hours of lectures and 20 hours practical classes.

Course Outline:

Topic 1. Evolution of Object Observation Systems.

The emergence of the object and the subject of study. The principle of completeness of the observation system. Psychological mechanisms of search activity. Classical science and techno-science.

Topic 2. Management of R&D.

Seven stages of the direct task of cognition. Cases of the discovery of radioactivity by Becquerel and the 'tamed lightning' by Franklin. Differences between fundamental and applied research. Classification of random discoveries according to A.S. Novikov and within the framework of the CSD representation. The specifics of scientific research methods. Types of research and the results they provide. A case study on sports fans. Verification of scientific concepts through experiments.

Topic 3. Practice of Experimentation and Data Analysis.

Golden rules for recording results. Protocols of scientific research - types and purpose. Purposeful creation and improvement of experimental equipment. Cases of decisive experiments in archaeology, marketing, forensics, biology, and quality management.

Topic 4. Targeted Data Processing.

A case study on blondes and cigarettes. Data scaling: terminology, types of scales, criteria for choosing scales. The connection of the scale with the stage of the direct task of cognition - lessons for experiment management. Data accuracy, statistical hypotheses, and correlations.

Б1.В.ДВ.02.02 Computational experiment

Elective Discipline.

Third semester, credit.

Language of instruction - English.

The total workload of the discipline is 3 credits, 108 hours, including: 6 hours of lectures and 20 hours of practical classes.

Course Outline:

Topic 1. Introduction to Experimental Design.

This section covers an introduction to experimental design, basic terminology used in experimental design theory, and the fundamentals of mathematical statistics. Elements of mathematical statistics, basic characteristics of random variables, and fundamentals of hypothesis testing.

Topic 2. Regression and Variance Analysis.

This section explores the basics of regression and variance analysis and their application in experimental design. The goals and objectives of regression and variance analysis, and their role in experimental planning.

Topic 3. Full Factorial Experiment.

This section discusses the principles of selecting the experimental domain, choosing the baseline level, defining the variation intervals, full factorial experiments, and the principles of constructing a 2^k design. Full factorial experiment.

Topic 4. Fractional Factorial Experiment This section covers fractional replication, the purpose of using fractional replication, the efficiency of replication, and the characteristics of replications with different fractions. Fractional factorial experiment. Selection of half-replications.

ФТД.01 TSU Digital Educational Environment

Elective Discipline.

First semester, credit.

Language of instruction - English.

The total workload of the discipline is 2 credits, 72 hours, including: 18 hours of lectures and 18 hours of practical classes.

Course Outline:

Topic 1. Student's Personal Account at Tomsk State University (TSU).

References. TSU Orders. Curriculum. Current Academic Performance. Campus Courses.

Topic 2. Moodle Electronic University.

Introduction to the electronic university.

Topic 3. Flamingo: Multifunctional Service for TSU Students.

Participation in events. Portfolio (real). Portfolio (fake). My Work. Scholarships and Grants.

Topic 4. TSU Electronic Library.

Introduction to the library. First-Year Student Bookshelf. Reading Rooms.

Document Citation Features. Graduation Papers.

Resources and Opportunities of TSU Scientific Library. Virtual Exhibitions.

Topic 5. TSU Museums.

Immersing into the university environment. Introduction to TSU's electronic cultural environment. Introduction to TSU Museums.

Exhibits from the university's museum collection. Mansi Folklore in V.N. Chernetsov's Recordings.

Б2.О.2.01.01(У) Research experience: Introductory Practice

Type: Educational.
Category: Introductory Practice.
Compulsory practice.
First semester, credit.
The practice is conducted at TSU.
Method: full-time (stationary).
Form of implementation: according to the schedule and curriculum.
The total workload of the practice is 3 ECTS credits, 108 hours.
Duration of the practice: 2 weeks.

Б2.О.2.02.01(Н) Research work 1

Type: Practical.
Category: Research Work 1.
Compulsory practice.
Second semester, credit.
Third semester, graded credit.
The practice is conducted at TSU/enterprise.
Method: full-time (stationary).
Form of implementation: according to the schedule and curriculum.
The total workload of the practice is 8 ECTS credits, 288 hours (4 credit units, 144 hours in the 2nd semester and 4 credit units, 144 hours in the 3rd semester).
Duration of the practice: 38 weeks (18 weeks in the 2nd semester, 20 weeks in the 3rd semester).

Б2.О.2.02.02(Н) Research work 2

Type: Practical.
Category: Research Work 2.
Mandatory practice for study.
Fourth semester, graded credit.
The practice is conducted at TSU/enterprise.
Method: full-time (stationary)/external.
Form of implementation: according to the schedule and curriculum.
The total workload of the practice is 18 ECTS credits, 648 hours.
Duration of the practice: 12 weeks.