ITMO UNIVERSITY

EXCHANGE COURSES SYLLABI

ECONOMICS AND INNOVATIONS	
Innovative Economy and Knowledge Economy **Fall semester** **3 ECTS**	The main goal of this short-term program is the formation of competencies necessary for the training of personnel who have economic thinking, capable of analyzing economic problems at the micro, meso and macro level, as well as acquiring practical skills for their use in professional activities. The objectives of the course are to provide students with the following professional skills and competences: ▪ knowledge of economic terminology, ability to apply it in professional activities; ▪ the understanding of principles of the knowledge economy and the interrelationship of basic economic processes and phenomena; ▪ the comprehensive understanding of the core idea of knowledge & innovation management to ensure the competitiveness of the organization; ▪ ability to manage the development of the organization, analyze and develop the organization's strategy on the basis of modern methods and advanced scientific achievements; ▪ ability to conduct research, process data received and analyze the results; ▪ ability to manage knowledge and innovations, create databases and knowledge bases, knowledge management systems and innovative organization processes; ▪ ability to identify promising areas of scientific research, to substantiate the relevance, theoretical and practical significance of the problem being studied; ▪ skills in analysis for making managerial decisions. ▪ possession of methods of strategic management of knowledge and innovations; ▪ the ability to form systems of knowledge management and innovation processes.
Human Capital in Innovative Economy **Fall / Spring semester** **3 ECTS**	The main goal of this short-term program is formation of students' theoretical knowledge and practical skills in the field of investing in human capital The objectives of the course are to provide students with the following professional skills and competences: ▪ understanding the essence of the theory of human capital; ▪ knowledge of the basic forms of human capital and their content; ▪ knowledge of the methods of investing in human capital; ▪ ability to determine the effective investment system human capital; ▪ the ability to assess the return on investment in human capital; ▪ the ability to use ways to improve the effectiveness of human capital; ▪ ability to conduct research, process received data and analyze the results; ▪ ability to manage the development of the organization, analyze and develop the organization's strategy based on modern methods and advanced scientific achievements.

Project Management **Fall / Spring semester** **3 ECTS**	The goal of this course is to gain basic knowledge about effective and professional project management based upon PMBoK-Guide and to provide practical wisdom for applying that knowledge to projects. The course introduces project management from the standpoint of a manager who must organize, plan, implement and control tasks to achieve an organization's schedule, budget, and performance objectives. The following tools and concepts are studied: ▪ project charter, ▪ scope statement, ▪ work breakdown structure, ▪ project estimating, ▪ scheduling methodologies. Students will be introduced to the roles of project and program managers in current business enterprises and to the triple constraints of scope, time and cost. After completing this course, the students should be able to: ▪ apply project management methodologies, processes, and tools to execute complex projects in organizations; ▪ Examine the roles that project management play in accomplishing an organization's strategic objectives; ▪ Develop effective approaches for managing high-performance project teams, communication strategies, and best practice closeout strategy that maximizes the value of the project experience; ▪ Critique the impacts of schedule, cost, and scope elements in projects and analyze different techniques for managing risks; ▪ Create project Charters, Scope statements, Work Breakdown Structures (WBS), Project Network Diagrams, and Responsibility Assignment Matrix (RAM). By the end of the module, the participants will improve their ability to manage projects effectively. In particular they will be better able to: ▪ operate more competently as a member of a project team, and ultimately as a project manager; ▪ understand the competencies a project manager needs and the organizational and leadership challenges they face; ▪ logically plan, schedule and control projects using project management tools and techniques; ▪ understand the basic principles of the main project management methodologies, such as ▪ PMBoKand PRINCE2. Course structure: Module 1: Project Fundamentals and Overview Module 2: Organizational Influences and Project Lifecycle Module 3: Project, Program, Portfolio Management Module 4: Project Structure Module 5: Recourse Management Module 6: Project Personnel Module 7: Project Communications and Organizational Issues

Innovation Management **Spring semester** **3 ECTS**	The Innovation Management course is has following goals and study objectives: ▪ develop a comprehensive understanding of the role and strategic relevance of innovation in the greater competitive context of the firm's strategy ▪ understand the role of innovation as a strategic mechanism for differentiation leading to the creation and delivery of superior value offerings ▪ view innovation from multiple perspectives, including its strategic, process, organizational, learning and linkage dimensions ▪ understand innovation as a strategic and dynamic capability ▪ develop an understanding of the relevant analytical frameworks relating to the organization's innovation performance By the end of the course it is expected that students will have acquired following competences: ▪ ability to demonstrate a deeper understanding of the strategic role and contribution of innovation within the greater context of the organization's strategy ▪ ability to explain key innovation concepts, notions and frameworks and their relevance to the business strategy of the organization ▪ ability to apply frameworks to analyze and assess the organization's current innovation performance ▪ ability to identify appropriate interventions for improving the organization's innovation performance ▪ be competent in elaborating on how thinking on innovation is changing and evolving, and the implications of this emerging thinking for a firm's competitive performance
Innovation Systems: Russian Federation Development **Spring semester** **3 ECTS**	The description of the course is next: "The main goal of this short-term program is to acquaint students with the theory of innovation systems and provide them with practical skills in evolvement into the Russian innovation system business based on innovations and new technologies. The objectives of the course are to provide students with the following professional skills and competences: ▪ the ability to evaluate the macroeconomic environment influence on the business and local authorities; ▪ the ability to analyze innovative potential of a country and to implement instruments of the innovative development; ▪ skills of search and selection mechanism to support the innovation activities of the organization in the Russian Federation"
Technology Entrepreneurship **Spring semester** **3 ECTS**	The Technology entrepreneurship course provides students with knowledge in current economic situation: trends, innovations and technology entrepreneurship. Entrepreneurship –basic definitions and approach. Technology entrepreneurship as the environment for innovations. Current stage of development of the entrepreneurship in different countries. Future trends in the economic situation in Russia and the world: strategic sectors for development. Concept of open innovations and technologic development. Transfer of technologies and technology brokering. ▪ Entrepreneurship in Russia: how to start? ▪ Forms of doing business in Russia, ways of support, taxation systems, role of small business, international businesses and investment support. Intellectual property, ways of protection. ▪ "Imagine and create it" Generating business ideas and creating innovations. ▪ "Design thinking" method of creating innovations, techniques of "World café", brainstorming. ▪ "Plan it" Business planning for technology entrepreneurs: basic principles and models in the current situation.

	▪ Stages of business development.Basic principles of lean startup. Business model. Kanvas model. Project planning: teamwork, deadlines, directions, responsibilities ▪ "Plan it" Business planning for technology entrepreneurs marketing aspects. ▪ Market analysis: trends, saturation's evaluation, segmentation. Competitive analysis, pricing, promotion and distribution. ▪ "Plan it" Business planning for technology entrepreneurs: financial and investment aspects. ▪ Planning resources: tangible and intangible. Creating budgets and reports: BS,PL,CF. Sources of capital. Investment Plan and Proposal: P&P but different. Economic efficiency, metrics for technology startups. ▪ "Plan it" Business planning for technology entrepreneurs: avoiding risks. ▪ Risks classifications, instruments of risk management. ▪ "Plan it" Ways of commercialization. ▪ Patents, licenses and startups as ways to commercialize your technology. ▪ "Present it" Presentation as the successful instrument of the promotion of your project. ▪ NABC method from Stanford Research Institute. Elevator pitch: guide book for presenters.
Digital Marketing **Fall / Spring semester** **3 ECTS**	The aim and objectives of the short-term international educational module is to form the listener's understanding of modern methods of goods and brands promoting in digital media and communication (digital media). The goal of the course is to acquire the following professional competencies for students: ▪ understanding the current trends in the development of digital marketing and the prerequisites for their formation; ▪ skill of identifying the available brand promotion method; ▪ ability to evaluate the effectiveness of the use of a particular promotion channel; ▪ ability to interpret current business objectives in specific tasks for the marketing department.
Russian and International Financial Systems **Spring semester** **3 ECTS**	The purpose of this course is to teach students the theory of Russians and international financial systems and acquire practical skills in analyzing the patterns of international monetary and financial relations development, the mechanism for their implementation in various forms. Students will acquire ▪ the ability to identify the type of Russian and international financial systems and determine their main development trends; ▪ skills in reading and analyzing companies' reports according to IFRS; ▪ skills of analyzing the world economic situation with the formation of a forecast of its development on the basis of existing patterns.
Urban Development and Planning **Fall / Spring semester** **3 ECTS**	The course is offered in the form of practical classes that include interactive forms of training: interactive mini-lectures, case studies, brainstorm, watching video-materials, discussion, simulations and business games. Mandatory attendance, activity, involvement in the debate, analysis of case studies, business games determine the success of a training course. Independent work includes reading literature, analysis of the international instruments and standards, data gathering as a special task for the field work, statistical information gathering, and field studies. The competences gained within the studies include:

	The main provisions of the concept of sustainable development, aims and objectives of applied research in this field, methods of data collection and analysis for the purposes of SD study the nature of global environmental problems, the causes and effects of global urbanization, methods of systematizing and analyzing of scientific, technical, technological, socio-economic information, principles of design of the scientific, technical and analytical reports, publications and presentations. The students will learn: ▪ to select the methodology and methods for data collecting and analysis of the obtained results ▪ to interpret the data and provide the significant results ▪ to determine the causes and effects of global problems in the context of urbanization ▪ to use the modern information and communication technologies for the analysis of documented results of applied research
Intellectual Management of Creative Projects **Spring semester** **3 ECTS**	Main topics: ▪ creative industries and project management in interfaced hi-tech innovation processes. Knowledge management and strategic thinking; ▪ the lifecycle of project work in the field of art and technology. Creative groups and specifics of intragroup communication among interdisciplinary specialists. Updating, evaluation and management of intellectual resources in projects with creative and innovative aspects - principles and methods; ▪ native interaction technologies and customizable processes. Management models, analytics and resource logistics, optimality criteria in creative projects.
Contemporary Art **Spring semester** **3 ECTS**	Main topics: ▪ art of the 20th-21st centuries. Avant-garde, modernism, postmodernism practices; ▪ development of a conceptual framework of abstract art, minimalism, conceptualism. Social history of the 20th century art. Formalism and structuralism; ▪ poststructuralism and deconstruction. Art as modern language. Philosophy and aesthetics of contemporary art: categories and discourse. Contexts of contemporary art. Performative practices — actionism, performance and happening. Art object and installation — articulation and expression of the author's position, meanings, subjective perception.
Art and Natural Sciences: Theory, Aesthetics, Discourses **Spring semester** **3 ECTS**	Main topics: ▪ critical and theoretical reflection on the issues of new technologies development in modern techno-biological art. Theory, philosophy and practice of bio art; ▪ experiments with biological materials — discursive, semantic and aesthetic aspects of Art & Science projects. Contemporary art and optics; ▪ aesthetic aspects and visual perception of optical effects. Wave and sonar studies in art projects. Network projects (neuro-art using biological material).

ITMO UNIVERSITY

ICT & PROGRAMMING/TECHNOLOGY	
HIGH-PERFORMANCE COMPUTING DEPARTMENT	
Evolutionary Computing **Fall semester** **6 ECTS**	Objectives: ▪ Students will study the basic principles and schemes of evolutionary algorithms (EA), learn how to design and implement EA for various optimization problems, get skills to tune and test EA, examine parallel schemes of EA. Contents Evolutionary computing is a widely used optimization techniques. The main goal of the course is to familiarize students with basic concepts and principles of design of evolutionary algorithms (EA). The course includes theoretical basis, examination of the main components of EA and how to implemnent them. Further, the course considers methods of increasing the performance of algorithms and schemes for implementation of high-performance EA based on multiprocessor and distributed systems, as well as with the usage of GPU. During the course, students are involved not only in theoretical aspects, but also in demonstrations and analysis of real solved problems with the usage of evolutionary computing methods. Classes carried out in the form of lectures with elements of the discussion, where such questions as: "In what case and which EA algorithm is better?"; "For which problems EA can be applied?"; "Which set of parameters is it worth to choose during implementation of EA?" can be discussed. The main practical assignment represents a development and implementation of EA for the typical optimization problem, where students' algorithms are compared with each other in a competitive way.
Introduction to Big Data **Fall semester** **6 ECTS**	Objectives ▪ Study of the main reasons of Big Data formation. It's detection and identification. ▪ Introduction to Grid technologies, WMS, MapReduce, stream data processing ▪ Understanding of MapReduce principles and Apache Hadoop technology ▪ Understanding of HDFS principles and building of Apache Hadoop infrastructure ▪ Introducing to Apache Storm Technology ▪ Main topics of the discipline: ▪ Definition of the term large data and the basic model. Use of large data. The role of large data in the national economy. ▪ Requirements for the profession of analytics of large data. ▪ The main stages of the life cycle. Collection, consolidation and cleaning of data. ▪ Correlation coefficient. Graphical representation. Statement of the problem of regression analysis. Linear regression. Least square method. Their role in the analysis of large data. ▪ Data collection and consolidation, data visualization, R language for analytics, work with DBMS. ▪ Hadoop, HDFS, Map / Reduce, YARN, Storm, Apache Spark. ▪ Importance of the phenomenon of large data for the development of society and science. Causes of the trend of large data. ▪ Problems and opportunities associated with the appearance of large data.

Technologies and Infrastructure for Big Data **Spring semester** **4 ECTS**	Students will study the theoretical bases of the applied data processing algorithms and methods of combining algorithms to achieve the best result, the skills of analyzing and evaluating research activities in accordance with generally accepted international norms and ethical standards for testing and research involving people, skills in working with software interfaces for large-scale processing systems data for packet and stream data processing, skills of working with the MLLib machine learning library. Students will learn: ▪ the basic mechanisms and algorithms for analyzing complex and large data and extracting knowledge from them; ▪ principles of data processing, storage and protection; ethical and legislative norms for working with large data; ▪ principles of construction and the basis for organizing the development of modern software solutions for processing large data; ▪ principles of processing large amounts of data to extract knowledge based on machine learning methods; to design and develop complex data processing solutions using one or more data mining and retrieval algorithms; ▪ to develop new algorithms based on existing ones, apply knowledge of the norms and principles of storage, and protect data to assess scientific activity in terms of the potential impact on society, design and develop basic software applications for data processing using a computational cluster based on modern technologies quipment big data, apply machine-learning techniques to extract knowledge using modern large data processing systems. **Key topics:** ▪ The main stages of the development of large data processing systems, the main types of systems and their purpose, the evolution of data processing methods. ▪ The purpose of the distributed HDFS file system, the basic principles of the HDFS device, the procedure of replicating data and providing fault tolerance. ▪ History of the origin of technology, the principles of building data processing based on MapReduce, the patterns of MapReduce. Architecture and principles of the Apache Zookeeper device, consensus algorithms, PAXOS algorithm. ▪ Assignment and tasks of the infrastructure manager, the architecture and principles of the YARN device, the architecture and principles of the Mesos device, a centralized and two-level approach to planning. ▪ The principles of organizing batch data processing, architecture and principles of the Apache Spark device, data processing with the help of Spark. ▪ The principles of streaming data processing, the architecture and principles of Apache Kafka and Apache Flink, the processing of streaming data using Spark Streaming and Apache Flink. ▪ The principles of the organization of interactive data processing, the architecture of Lambda and Kappa, interactive processing of data using Spark SQL. ▪ Representing graph data for batch processing, processing graph data using Spark GraphX.

Concurrent and Multithreading Programming **Fall semester** **4 ECTS**	Objectives Students will learn: ▪ to find out the basic directions of development of high-performance computers and basic classification of multiprocessor computer systems ▪ to apply the basic techniques and formal model of parallel programming ▪ to use tools for parallel programming on systems with shared memory ▪ to design parallel algorithms for computational problems ▪ to implement parallel programs for computing systems with shared memory ▪ to analyze speedup and efficiency of parallel algorithms. Contents Course is intended to introduce students with the basics of high-performance computing for systems with shared memory. On completion of the course students will be able to apply their knowledge to design and implement parallel algorithms. Students will get basic skills to optimize their programs.
Computational Intelligence **Fall semester** **6 ECTS**	Objectives Students will learn: ▪ the basic tasks of machine learning, the basic concepts and basic mathematical apparatus of fuzzy logic, the basic concepts and principles of the operation of artificial neural networks, the main varieties of evolutionary algorithms, examples of the application of computational intelligence methods for solving problems; ▪ to set a task and develop an algorithm for solving it using the methods of computational intelligence, analyze scientific literature sources, analyze the solutions obtained, analyze the problem for choosing the best method of computational intelligence or a hybrid method suitable for a specific task, analyze the work of methods of computational intelligence with the identification of their strengths and weaknesses, to carry out analysis of the tuning parameters of neural networks, evolutionary algorithms and fuzzy method. Students will study the technology of applying the methods of computational intelligence to solve practical problems, methods of intellectual data analysis, the skills of creating and testing artificial neural networks, evolutionary algorithms and fuzzy methods in one of the high-level programming languages, to analyze the work of methods of computational intelligence with the identification of their strong and weak parties, to carry out analysis of the adjustment of parameters of neural networks, evolutionary algorithms and fuzzy methods, methods of obtaining data from different cing available sources. Contents Main topics of the discipline: ▪ Biological and formal neuron. Architecture of neural networks. Classification of neural networks. Basic principles of training neural networks. Perceptron and multilayer neural network. Retraining of the network. Methods for calculating the output of an INS. ▪ Neural networks with feedbacks. Hopfield Networks. Maps of Kohonen. Radial-basic neural networks. General information on the application of neural networks to solve problems of classification, approximation, modeling and control. Features of

	practical application of neural networks. ▪ Evolutionary algorithm. Types of evolutionary algorithms. Function fitness. Integer and real coding of information. Basic operators of evolutionary search and their varieties. Application of evolutionary algorithms for solving optimization problems. ▪ Parameters and adaptation of parameters. The theorem on the lack of free meals. Evolutionary strategies. Algorithms for estimating distributions. Systems of classifiers. Genetic programming. Algorithm of differential evolution. Features of the practical application of evolutionary computations. ▪ Linguistic variable. Fuzzy sets. The membership function. Basic operations and relations of fuzzy logic. Algorithms of fuzzy inference Mamdani and Sugeno. A model of the singleton type. Fuzzy databases. Calculations with words. Comparison of fuzzy and probabilistic systems. Features of practical application of systems with fuzzy logic. ▪ Neuroevolutionary algorithms. Neural networks. Evolutionary fuzzy systems. Sharing the methods of computational intelligence and machine learning ▪ Solution of problems of classification, approximation, clustering, control. Open libraries and programs for methods of computing intelligence.
Scientific Visualization and Virtual Reality **Fall semester** **3 ECTS**	Objectives Students will learn: modern GPU architecture, modern GAPI and shading languages, modern rendering techniques, approaches for distributed rendering. Students will learn to develop a substantial virtual reality project. Contents In this course, you will learn architecture of modern GPUs, modern GAPI, and one of the shading languages. You will learn how to synthesize highly realistic images using different approaches like forward shading and deferred shading, how to render natural phenomena, and how to perform post-processing on such images.
Introduction to Visualization **Spring semester** **3 ECTS**	Students will learn the basic concepts of information theory, their relationship with consumer characteristics of information transmission and storage systems, the principles of constructing effective methods of compression and coding of information, main characteristics and areas of application of algorithms; formulate in the form of theorems and prove statements about the potentially achievable characteristics of information processing and transmission systems, formalize the requirements and limitations on the development of information systems, and measure real characteristics with theoretical limits. Students will acquire the skills of constructing various kinds of diagrams for the design and documentation of software, the skills of developing algorithms for effective information processing, namely, the system for compressing discrete and analog information and the system of protecting information from interference and distortion in communication channels. Key topics: ▪ History of visualization development. Basic concepts and directions of visualization. Data: data abstractions and their types. Alphabet of visualization ▪ Sketch and design of visualization solutions. Visual perception of a person. Awareness of images. Perception of color. Objectives: abstractions of tasks and ways of their statement. Human-computer interaction. ▪ Visualization of data. Networks and graphs. Visualization of text and documents. Visualization of spatial data. Volumes,

	flows, maps. Social visualization. Analysis of social data. Visualization for society. Visualization and art. Visualization as an art.
Machine Learning Technologies **Spring semester** **4 ECTS**	Objectives Students will get an idea about the basic tasks and methods of machine learning and data mining; examine the statistical foundations of machine learning theory.; learn how to solve the problem of classification, egression, clustering, using machine learning methods and algorithms and evaluate the quality of the solutions; learn to apply software for machine learning to solve the domain-oriented problems. Contents The course combines lectures on statistical theory of machine learning with a practical mastering of efficient algorithms to solve real-world problems. The course consists of three sections, covering methods of classification and regression, unsupervised learning, and neural networks. As a result of the successful completion of the course the student will acquire knowledge extraction skills useful for professional work in any field related to the accumulation and processing of large amounts of data.
Methods and Models for Multivariate Data Analysis **Spring semester** **4 ECTS**	Objectives Students will improve backgrounds in probability theory; develop skills in probabilistic modelling and statistic assessment. Contents Main topics of the discipline: - Probabilistic models for random variables. Univariate random variable. CDF and PDF. Probability distribution parameters estimation. Probabilistic interval. Confidence interval. Tolerant interval. - Probabilistic models for random variables. Multivariate random variable. Regression and correlation analysis. Linear and non-linear regression. Canonical correlations. Principal component analysis. Empirical orthogonal functions. Factor analysis. ANOVA method. Cluster analysis. Multidimentional interval estimates. Nonlinear methods for dimensionality reduction.
COMPUTER TECHNOLOGY DEPARTMENT	
Machine Learning **Fall / Spring semester** **5 ECTS**	Objectives ▪ Models selection and hyperparameters tuning; ▪ Basic machine learning algorithms for classification, regression analysis and clustering; ▪ Data preprocessing: features extraction and outliers detection Contents Machine learning gives computers the ability to learn without being explicitly programmed. Nowadays machine learning is rapidly introduced into all domains. This course will provide an overview of many concepts, techniques, and algorithms in machine learning, from basic classification with decision trees and clustering to support vector machines. By completing this course, you will learn how to apply, test, and interpret machine learning algorithms as alternative methods for addressing your research questions.
Programming Languages **Fall semester** **3 ECTS**	The course helps to improve the ability to develop and analyze conceptual and theoretical models of the solved tasks of design and production and technological activities, the ability to organize corporate learning processes based on information technology and the development of corporate knowledge bases and the ability to apply modern methods, algorithms and tools for data analysis.

Advanced Algorithms and Data Structures **Fall semester** **3 ECTS**	This course helps to master the skills of designing algorithms, skills in implementing algorithms using the programming language, skills of experimental research on the effectiveness of the algorithm. Also, students will able to prove the correctness of the compiled algorithm and evaluate the main characteristics of its complexity, solve typical problems of discrete mathematics arising in educational and professional activities.
Deep Learning **Fall / Spring semester** **2 ECTS**	In this course, you'll develop a clear understanding of the motivation for deep learning, and design intelligent systems that learn from complex and/or large-scale datasets. You will learn how to train and optimize basic neural networks, convolutional neural networks, long short term memory networks, and modern state-of-the art architectures.
Big Data **Fall semester** **4 ECTS**	The course of Big data will help you to learn the theoretical basis of data processing, theoretical types of processing large amounts of data, the ability to process large amounts of data in the calculation of software solutions, modern methods of processing large amounts of data and tools. Also, the course will give the opportunity to improve skills in working with the processing of large amounts of data, skills in processing large amounts of data from algorithmic and intelligent systems and skills in applying large data processing for use in research activities.
Genetic Algorithms **Fall semester** **4 ECTS**	The aim of the course is to introduce genetic algorithms and to give students practical experience in implementing and experimenting with them. The course will equip them to be able to assess the suitability of genetic algorithms for specific problems.
Social Media Data Analysis **Fall semester** **5 ECTS**	After this course you will know main characteristics and areas of application of social data analysis algorithms, basic concepts of social data analysis and basic mathematical methods of data analysis. By completing this course, you will master the skills in working with mathematical methods of data analysis, ways to assess the effectiveness of projects in different categories and he skills of developing a system to protect information from distortion.
Mathematical statistics **Spring semester** **3 ECTS**	This course provides students with decision theory, estimation, confidence intervals, and hypothesis testing. It introduces large sample theory, asymptotic efficiency of estimates, exponential families, and sequential analysis.
Optimization **Spring semester** **5 ECTS**	This is an introductory course to the stochastic optimization problems and algorithms as the basics sub-fields in Artificial Intelligence. We will cover the most fundamental concepts in the field of optimization including metaheuristics and swarm intelligence. By the end of this course, you will be able to identify and implement the main components of an optimization problem. Optimization problems are different, yet there have mostly similar challenges and difficulties such as constraints, multiple objectives, discrete variables, and noises. This course will show you how to tackle each of these difficulties. Most of the lectures come with coding videos. In such videos, the step-by-step process of implementing the optimization algorithms or problems are presented. We have also a number of quizzes and exercises to practice the theoretical knowledge covered in the lectures.

Natural Language Processing **Spring semester** **5 ECTS**	This course aims to help students learn general principles of constructing speech processing systems, the definition of the main formal systems used in the development of text analysis algorithms, modern methods of assessing the quality of automatic text processing. By completing this course, you will able to master skills of constructing syntactic and morphological parsers, creating modules for the primary processing of text,skills in interpreting the results of the basic algorithms of automatic text processing.
MECHATRONICS DEPARTMENT	
Dynamics of Robotic Systems **Fall semester** **3 ECTS**	The course "Dynamics of Robotic Systems" is devoted to the study of multi-body manipulative and locomotive robotic systems' dynamics. The problems of optimal trajectories planning and high-performance control of robot motions cause an increased interest in efficient tools for analytical and numeric representation of system dynamics. The relevance of the problems considered within the course is greatly influenced by the expansion of robotic systems towards various fields of engineering and industrial production, while the range of industries where robotic complexes are used is constantly growing, including space and aviation equipment, automotive industry, machine tool building, etc. Today's specialist in the field of robotics must fully master the main issues related to the analysis, programming of the movement of robotic mechanisms, to be able to understand the basic laws and features of controlled dynamics of robots. Within the course we will study basic concepts such as generalized forces and moments, Lagrangian and Hamiltonian of the system, holonomic and non-holonomic constraints, configurational and operational spaces of robots, basic principles such as the principles of D'Alamber and Hamilton, and the most efficient approaches for modeling the dynamics of robotic systems, such as the methods of Newton-Euler and Euler-Lagrange as well as its software implementation. Special attention is paid to the identification of robotic systems, as a way to obtain estimates of a priori unknown parameters necessary both for computer simulations, planning and analyzing motion as well as controllers design. Most of the examples studied within the discipline have practical motivation from the field of modern industrial robotics.
Cyber Physical Systems and Technologies **Spring semester** **3 ECTS**	Main topics: ▪ principles, methods and stages of cyberphysical systems implementation; principles of checking of cyberphysical systems protection from the destructive information impact; ▪ modern approaches, methods and tools for the cyberphysical systems development and operation; ▪ methods of calculation and instrumental evaluation of the protected cyber-physical systems implementation results. ▪ principles and methods of cyberphysical systems analysis; ▪ instruments for information search and summarizing. ▪ structures of various cyber-physical systems; ▪ computational tools for cyberphysical systems design and implementation; ▪ methods of the life cycle description and supporting technologies for cyber-physical systems.
Modeling and Control of Robotic Systems **Spring semester** **3 ECTS**	Main topics: ▪ construction of mathematical models of robotic systems motion; ▪ analysis of kinematics and dynamics of robotic systems using different approaches and modifications; ▪ control algorithms for robotic systems in various software environments. ▪ the main system solutions for design, construction and development of cyberphysical systems.

	▪ the concepts of the automated control system of technological processes. ▪ the modern methods of motion control and trajectory planning for robotic systems. ▪ scenarios of automation of technological operations using robotic systems.
Adaptive and Robust Control **Spring semester** **3 ECTS**	Main topics: ▪ algorithms of adaptive and robust control of linear and nonlinear systems; methods of practical implementation of algorithms. ▪ schemes in simulation environments (MatLab/Simulink, Scilab); engineering techniques to improve the robustness of control systems and their software support. ▪ debugging of hardware design schemes for solving problems of adaptive and robust control in mechatronic and robotic systems.
Control Systems Programming **Spring semester** **3 ECTS**	Main topics: ▪ principles of system approach for control system software design. ▪ instruments for design and implementation of the control algorithm for different structures of control devices. ▪ software for programming of computing devices for control systems of electric drives, mechatronic and robotic systems.
Robotic Systems Hardware **Spring semester** **3 ECTS**	Main topics: ▪ technical implementation of digital control devices and information processing, their typical mathematical models. ▪ parameters of mathematical models of digital control systems. ▪ typical structures of digital control and information processing systems. ▪ algorithms of digital control devices and information processing.
Biomechatronic Systems Development **Spring semester** **3 ECTS**	Main topics: ▪ classification, state and prospects of modern mechatronics and robotics, main fields of application, their economic and social significance. ▪ typical design documentation; development of drawings of parts and assembly components by the computer-aided design; computer software packages in dynamic, static and strength calculations; basic understanding of the typical mechanisms, components and parts of machines and devices, their purpose, comparative characteristics, capabilities and feasibility of use; ▪ classification, state and prospects of modern robotics, the main fields of application, economic and social importance, the history of robotics, related new areas of science and technology (mechatronics); world experience and existing ideas and developments in the mechanics and management of modern manipulation robots; composition and structure of mechatronic manipulation systems for various applications, considering a complex of technical, economic, environmental, social and other requirements and evaluation criteria; ▪ development of spatial representation and imagination, constructive and geometric thinking, the ability to analyze and synthesize mechatronic systems; basics of design and construction of mechatronic systems; system of basic constant

	mechanical parameters, their role in dynamics and statics and methods of identification; basics of standardization; ▪ structural models of mechatronics objects and models of external operating conditions of objects.
Robot Sensing Systems **Spring semester** **3 ECTS**	Main topics: ▪ principles of neural networks on the example of convolutional neural networks in solving classification problems. ▪ possible means of integrating neural networks into mechatronic modules.
CAD Systems **Fall semester** **3 ECTS**	Main topics: ▪ fundamentals of standardization, the basic requirements set out in the regulatory and technical documentation, ▪ spatial transformation of three-dimensional objects displayed in projection planes
Construction of Mechatronic Modules **Spring semester** **6 ECTS**	Main topics: ▪ methods of automatic control theory used in mechatronic modules and robots. ▪ automated control systems for robots and manipulators. ▪ the main elements of the mechanical part of robots and mechatronic modules and systems; electromechanical elements of mechatronic systems; information devices of robots and mechatronic systems; quality indicators of mechatronic systems; materials for mechatronic systems development. ▪ Knowledge: advantages and disadvantages of the mechatronic approach; stability of the walking machine. ▪ principles of energy recovery to create energy efficient robots ▪ simulation of motion and functioning of designed systems and robots in V-REP, Gazebo and SimMechanics programs.
Smart Materials in Mechatronics **Spring semester** **3 ECTS**	Main topics: ▪ regularities underlying the interdependence between the composition, structure and properties of materials; ▪ the physical patterns underlying smart materials.
Modeling and Control of Mechatronic Systems **Spring semester** **3 ECTS**	Main topics: ▪ the basic principles of reducing economic costs in the development of mechatronic and robotic devices. ▪ system structure and components, stable control algorithms and subsystems for emergency scenarios. ▪ experimental modeling systems and tools for comparative evaluation using simulation systems. ▪ principles of planning and calculation of necessary resources.
ECOLOGY/ENVIRONMENTAL MANAGEMENT DEPARTMENT	
Corporate Environmental Management **Fall / Spring semester** **4 ECTS**	The course examines corporate environmental management strategies and tools for effective management of resources and energy and decrease an environmental impact at the level of enterprise. The theoretical base includes obtaining the necessary knowledge and skills for the development, implementation and auditing of the environmental management system (ISO 14001), environmental performance assessment (ISO 14031), environmental product marketing (ISO 14020 group), environmental risks

	management (ISO 31000) and climate risks reduction (ISO 14064). Students obtain also required attitudes by participating in small groups discussions, fulfillment of practical works, which is carried out in the format of analysis of case studies. The course includes visits to industrial companies and master classes from environmental managers of the leading industrial companies of St. Petersburg.
Environmental Audit **Fall / Spring semester** **3 ECTS**	The course examines the procedure for environmental auditing of the companies in accordance with the requirements of ISO19011. The students learn the existing environmental regulation of the Russian Federation, as well as the requirements to the environmental protection at the companies' level. For better understanding application of the guidelines of ISO 19011 standard the course offers a series of practical works in small groups. During the practical works students can understand the material better by considering the real-life situations in the format of role games.
Organization of Cleaner Production **Spring semester** **3 ECTS**	By providing goods and services demanded by the public, businesses have to fulfill many vital social tasks including the task of environmental pollution prevention. The investments and innovations in industry drive economic growth and satisfy the demands of consumers. However, because of resources they consume, the processes that they apply or the products that they manufactured, business activities are so far the major contributor to environmental destruction and waste generation. The course offers a study of the theoretical foundations of the circular economy model and its application based on the Cleaner Production methodology. Usage of the problem based learning approach allows students to formulate the environmental problem at the company level and find out its solutions leading to "greening" an industry. In practical classes in small groups, students apply the methodology of Cleaner production to reduce the environmental impact of the enterprise and prevent inefficient use of resources and energy preventing environmental contamination at the sources. During the course students conduct a feasibility study of the implementation of Cleaner Production projects, which require investments. The course doesn't intend any prerequisites since interdisciplinary groups of students are the preference.
BIOCHEMISTRY DEPARTMENT	
Molecularly Organized Systems **Spring semester** **3 ECTS**	Main topics: ▪ Interdisciplinary, synergetic approach ▪ System models and graphical methods for describing model dynamics ▪ Entropy and information ▪ Fractals and dendrites ▪ Self-organizing systems in non-living and living nature ▪ Systems of" smart " delivery of active substances based on nanocapsules ▪ Self-healing systems ▪ Inanimate systems with gradients that can " talk" to the cell and to the microbiome
Advanced Materials **Spring semester** **6 ECTS**	Main topics: ▪ Functional nano-and macrostructured materials, their classification, structure and physical properties ▪ Physical and chemical basis of functional response of materials ▪ Physical and chemical aspects and technological methods of obtaining functional nanomaterials ▪ Zero-dimensional nanostructures

	▪ One-dimensional nanostructures ▪ Two-dimensional nanostructures and functional films ▪ Chemical methods for obtaining nanostructured materials ▪ Nanolithography and ink-jet printing technology
Advanced Methods in Chemical Nanoengeneering **Spring semester** **6 ECTS**	Main topics: ▪ Nanostructured materials and their characterization ▪ Transmission and scanning electron microscopy techniques ▪ Methods based on x-ray, synchrotron and neutron diffraction and scattering ▪ Methods of optical spectroscopy ▪ Methods of vibrational spectroscopy ▪ Investigation of disperse systems by dynamic light scattering ▪ Methods for characterization of porous structure and surface properties of materials ▪ Atomic force microscopy
Computational Methods and Modeling in Materials Chemistry **Spring semester** **3 ECTS**	Main topics: ▪ Basic principles of molecular modeling: main methods and their application ▪ Examples of application of molecular modeling methods in chemistry and nanotechnology
Smart Materials **Spring semester** **3 ECTS**	Main topics: ▪ Functional nano-and macrostructured materials, their classification, structure and physical properties ▪ Physical and chemical basis of functional response of materials ▪ Physical and chemical aspects and technological methods of obtaining functional nanomaterials ▪ Self-assembly and self-organization processes
Modern Technologies for Manufacturing Nanoscale Objects and Materials **Spring semester** **3 ECTS**	Main topics: ▪ Modern dynamics of nanostructured materials markets: current needs assessment and forecast for the future ▪ Modern technology of nanopharmaceutics and nanobioengineering ▪ Robotic nanoengineering and nanofabrication ▪ Aspects of new technologies introduction process and requirements to its documentary support
SOFT SKILLS	
Intercultural Communication **Spring / Fall semester** **3 ECTS**	The main goal of this course is to expose international students of ITMO University, specializing in different fields of study with the problems intercultural communication in the field of business-like cooperation and interpersonal communication within the different cultures. The main goal of the special course and seminar is to achieve cross-cultural competence in all dealings with multicultural colleagues and clients.

	Course objectives. Course objectives include detailed cross-cultural understanding that comes to cross-cultural competence in: ▪ knowledge, awareness and sensitivity in intercultural communication; ▪ ability to use and interpret case studies from particular cultures taking in the account the specific regional and country character; ▪ capacity to use cross-cultural interpretation of behavior and communication in everyday life and management; Intercultural communication skills in the new cultural context. The study of intercultural communication assumes putting the problems in the context of the global cooperation and the role of Russian university in this process.
Russian as a Foreign language **Spring / Fall semester** **3 ECTS**	The Russian Language Course is aimed at developing speaking, listening, reading and writing skills at the A1 level. Students will learn: ▪ to understand and use familiar everyday expressions and basic phrases; ▪ to introduce themselves and others and ask and answer questions about personal details such as where they live, people they know and things they have; ▪ to interact in a simple way provided the other person talks slowly and clearly and is prepared to help; ▪ to make simple conversation about their families, studies, daily lives and Russian culture.
English for Specific Purposes **Spring / Fall semester** **3 ECTS**	English for Specific Purposes classes are designed specifically for students based on their educational programs in order to provide them with specific skills and vocabulary that will help them advance further in their studies and careers: ▪ ESP for Information technologies ▪ ESP Robotics and Mechatronics ▪ ESP Management ▪ Other
Negotiation, Influence and Conflict Management **Fall semester** **4 ECTS**	We all negotiate every day. We communicate online and in person, with colleagues or in a store. The well-known negotiation techniques of hard and soft types, when there's a winner and a looser are now long forgotten. In a fast-paced world we all need extra negotiation skills that open new perspectives on reaching our goals and help us find creative solutions to daily challenges, taking into consideration interests of both sides. This course covers "Harvard" method, and "Kremlin School" approach. Among other things, the students will learn what the "bargaining arena" and the best alternative are. We will talk about getting out of standard negotiation traps and come to mutually beneficial agreements.
Emotional Intelligence **Fall semester** **4 ECTS**	The vortex of information that spins all of us demands that we perceive, digest and produce information very quickly. We can only be productive if we are emotionally stable, understand those we work and live with and enjoy ourselves to a certain level. This course will teach you how to analyze your own emotional state and control it; and how to account for the emotional natures of those around you in order to build productive relationships. Emotional literacy-intelligence with a heart-can be learned through the practice of specific transactional exercises which target the awareness of emotion in ourselves and others, the capacities to love others and oneself while developing honesty, and the ability to take responsibility for our actions.

Internationalization of research **Fall semester** **4 ECTS**	Internationalization of research course will provide you with the tools that help us organize ourselves in research environment, build a research team or become a part of one successfully, share your findings with the scientists in an oral or written form (presentation skills), present your research (participating in the conferences) or pitch your ideas to the investors. You will be able to write a good resume, know how to write a scientific article, locate funding to scaffold your research (apply for grants). In a nutshell, this course will teach you everything that an aspiring researcher needs to know to be successful.