SUMMARIES OF THE COURSES

for the master's program
«Renewable Solar Energy »
Educational direction
11.04.04 «Electronics and Nanoelectronics»

«Computer Technology and Simulation in Electronics»

A number of software packages are available to simulate electronics devices at the present time: Synopsys Sentaurus TCAD, FlexPDE, MathCAD. With simulation, it is possible to quickly find out the effect of parameters devices on the electronics devices performance, and some of the time-consuming and expensive prototyping steps can be avoided.

«Micro- and Nanotechnology Processes»

The “Micro- and Nanotechnology Processes” discipline forms knowledge about materials deposition, etch and modifying methods on micro- and nanolevel which used in solid electronics and integrated circuit components forming. Base processes and equipment used in conventional microtechnology and specific processes, permissive to form structures on molecular level and based on selforganization, selectivity, anisotropy abilities and matrices principle are studied. Discipline concludes lectures, practices and laboratories, self-dependent student’s work, including individual tasks and interdiscipline course project. Examination as control form is used

«Microprocessor Techniques»

Main objective of the «Microprocessor Techniques» discipline study is learning of the modern microprocessor families, microcontroller devices construction principles, microprocessor devices programming. During studying students get knowledge about components of the microprocessor systems; learn how to use cross-compilers for the software development in C programming language. Laboratory bench including modern high-efficiency ARM microcontroller and various input/output peripherals is used in the discipline lessons and laboratory practice

«Problems of Modern Electronics»

The main purpose of the discipline « Problems of Modern Electronics» is to introduce the latest trends and achievements in various promising fields of electronics. Studying of the discipline is reinforced by practical exercises aimed at acquiring the appropriate skills for formulating and solving problems when creating new components and technologies for nanoelectronics.

«Russian as a Foreign Language»

This program is pointed on providing training courses for foreign citizens who had not studied the Russian language before. It includes language and speech models based on the requirements for the Elementary certification level. Achieving this level in Russian will satisfy the foreign master degree students' basic communicative demands in social and cultural as well as in educational spheres of communication.

It provides students with the opportunity of mastering a set of instrumental competences, linguistic knowledge, among which the knowledge of Russian language is determining, which allows students to organize their speech in the communication process.

The content of the program involves implementation of flexible training models, depending on the communicative purposes, native language and students' individual features.

«Foreign Language»

The aim of the course is to provide students with practical use of foreign language (English, German, and French). The main task of the course is to use language for professional and social communication and focuses on the further development of language skills required for successful communication. The program characterizes the teaching material for providing systematic preparation in all four language skills - speaking, listening, reading and writing. The course includes the following modules (aspects): listening and conversation, reading, writing skills, translation and practical grammar. The modules differ in topics and vocabularies of teaching material and texts,

yet they are connected both with systematic development of all four language skills and major grammatical areas.

«Foundations of Scientific Research»

The discipline " Foundations of Scientific Research " is included into a base unit of a general scientific cycle of training of masters. The purpose of studying of discipline is acquaintance of masters with structure of scientific knowledge, with methods of scientific research, with functions of scientific theories and laws; expansion of their world outlook outlook; elaboration of ideas of criteria of scientific character and about requirements to which scientific research and its results has to answer.

«Interdisciplinary Project «Design, Technology and Metrology of Solar Cells and Modules»

The interdisciplinary project (TIR) solves the problems of calculation, computer simulation, design, production technology and metrology of thin film solar energy converters made of polycrystalline (amorphous) silicon, based on the knowledge and skills acquired by students in the process of learning at least two related disciplines of the master program "Renewable Energy" which are studied in 1-3 semesters.

«Solar Energy Materials»

The course "Solar energy materials" includes main branches of Condensed Matter Physics and Solid State Optics. The main points of the theory of electronic spectra of solids are discussed, along with the basics of the theory of radiation interaction with matter. The light absorption, reflective, refractive and other physical phenomena, which determine the optical properties of crystalline, disordered semiconductors and conjugated organics systems are considered. Special attention is paid to physical interpretation of studied phenomena, theoretical description and the most important experimental facts. Moreover, the novel approaches to use the nano- and bio-objects are considered to make the optimization of the body and the surfaces of the materials used in the general optoelectronics.

«Diagnostics of Solar Energy Materials and Structures»

The course "Diagnostics of solar energy materials and structures" is devoted to modern techniques and methods of diagnostics and characterization of materials and structures in micro- and optoelectronics. The main techniques used within the micro- and optoelectronics are explained. In particular, the subject is focused on the most widely used techniques such as charge-based and probe methods, as well as chemical and physical methods.

«Optics and Optical Measurements in Solar Energy»

The course covers basic optical and spectroscopic methods, techniques and equipment such as light photometry, UV/Vis spectrometry, Fourier transform infrared spectrometry, Raman spectroscopy, ellipsometry and interferometry, which are widely used in the diagnostics of materials and thin film structures of solar photovoltaics. The course also includes an introductory part dedicated to the fundamentals of geometrical and wave optics, laboratory workshops and seminars.

«Metrology of Solar Cells and Modules»

The following subjects will be considered during the study of this discipline:

«Sunlight, its characteristics» where the sunlight characteristics and methods of in door light parameters modeling, also a quality monitoring of parameters of sunlight will be considered.

«Reference solar cells and their design». The section is devoted to design of reference solar cells, ways of their calibration.

«Spectral characteristics of solar cells». In the given section techniques and the equipment for spectral characteristics measurement of thin-film solar cells, including multijunction cells are presented.

«Current-voltage characteristics of solar cells». The section acquaints with techniques and the equipment for measurement of the current-voltage characteristics of solar cells and solar modules, as well as specific features of tandem thin-film solar cells modules current-voltage characteristics.

«The photoinduced degradation of solar cells». The section acquaints with problems of the photoinduced degradation of thin-film solar cells and its characterization methods.

«Technology of Solar Cells and Modules»

The study of the subject includes the following questions: Prospects of solar energy. Classification of the photoelectric converters of solar energy. Basics of silicon thin-film solar modules production. Main steps of silicon micromorph solar modules production. Quality of gases and materials used for silicon micromorph silicon solar modules production. Basic procedures of fabrication of micromorph silicon solar modules. Substrate choice and preparation procedure. Deposition process of transparent conductive ZnO layer. Laser scribing. Deposition of photoactive absorbing amorphous and microcrystalline hydrogenated silicon layers. Back-end process: contacts application, edge isolation, lamination process, junction box assembly. Main trends of research for thin-film silicon photoelectric solar energy con-verters. Production lines for silicon based thin film solar modules. High-tech equipment used in silicon based thin film solar modules production.

«Laser Technologies in Manufacturing of Solar Modules»

The description of work programme contains information on physical fundamentals of laser technologies and architecture of industrial lasers. The requirements for lasers for microprocessing of materials are analyzed. Their main output parameters and features of operation are given. Case studies on applications of lasers for industrial processing of materials (mainly in microelectronics) are described. Separated part is dedicated to use of lasers in manufacturing the thin-film solar panels.

«Multijunction Solar Cells Based on AIII–BV Compounds»

The following subjects will be considered during the study of this discipline:

Band-gap structure of the materials for solar photovoltaics.Formation of the I-V curves of the one-junction and multijunction solar cells, their modification under

illumination, connection with basic properties of the semiconductor materialPractical approaches to minimization of the optical, recombination and ohmic losses in solar cells. Principles of design and practical use of the concentrator solar cells. Reliability and life time of the solar cells and photovoltaic systems. Perspectives of the solar photovoltaics.

«Solar Hybrid Power Systems»

The main types of solar hybrid power stations are discussed, and an overview of their most important parameters and characteristics is provided. Requirements for solar cells, wind power generators, energy storage systems, backup diesel-generators and other elements of hybrid power stations are considered. The basic principles of solar hybrid power stations design and operation are considered.

«Renewable Energy Sources»

Renewable energy sources use the energy of the sun, wind, rivers, sea tide, peat, forest and geothermal wells. These sources do not add CO2 to the atmosphere, unlike fossil - coal, oil, gas. There are two exceptions to this rule: 1) forest and peat are considered renewable due to the short-term conservation of CO2, which does not violate its balance on geological scales, 2) nuclear energy is classified as a fossil, since it affects the isotopic composition land on this scale.

The course "Renewable energy sources" contains the following topics: renewable energy sources; solar energy perspectives; photovoltaic solar energy converters classification; the main materials of photovoltaic solar energy converters; principle of operation, design and characteristics of photovoltaic solar energy converters. real photovoltaic solar energy converters parameters; energy loss in the solar cell; technology fundamentals for the formation of thin-film solar cells on the basis of thin films of various materials; features of photovoltaic solar energy converters based on a-Si:H; the main directions of increasing the efficiency of photovoltaic solar energy converters.

«Equipment and Automation of Solar Power Stations»

The working program is devoted to studying of the equipment of solar power stations. Photovoltaic modules only represent the basic element of a solar power system. They work only in conjunction with complementary components, such as batteries, inverters, and transformers. Power distribution panels and metering complete the energy conversion process. In the working program characteristics of the equipment of solar power stations are resulted.

«Energy Storage»

The course focused on the characteristics and principles of operation of various types of electric energy storage devices used in renewable energy. Particular attention is paid to electric batteries of various systems and supercapacitors, the positive and negative aspects of their use, current trends in production and use. Also considered are hydraulic accumulators, electrical energy storage devices based on compressed air and kinetic storage devices (flywheels)

«Hydrogen Energy»

The course focused on various aspects of the development of hydrogen energy, among others, the main methods for producing, storing, transporting hydrogen, hydrogen safety. Particular attention is paid to the production of hydrogen using energy obtained from solar modules and other renewable sources. The main types and structures of fuel cells, including solid polymer, solid oxide, melt-carbonate and phosphoric acid and alkaline fuel cells, are considered.

«Commercialization of Results of Scientific Research and Development»

Commercialization of the research work results is the process of involving them in the economic (commercial) turnover in order to ensure the innovative development of the national and international economy.

The relevance of this discipline is due to the need to modernize the economy in the context of changing the existing technological structure based on the realization of

the potential of high-tech branches of science and technology, including the «Digital Economy» program. The development and implementation of the research work results in the economic activities of organizations and enterprises is one of the key success factors for economic transformations.

The implementation of the tasks of innovative development requires a qualified and competent assessment of the economic efficiency of projects focused on the production of high-tech products and the promotion of new technologies.

The main goal of this discipline is to form a complex of knowledge, skills and practical skills of developing a business plan for the commercialization of innovative ideas in the form of creating new or improved types of products, goods, works and services studied in the course of R & D undergraduates.

Mastering a phased methodology for business planning and design of various innovative projects will ensure the acquisition of competencies required in solving the problems of outputting the results to sales markets and assessing their economic efficiency.

«Foreign Economic Activity of Organizations»

The expansion of foreign economic relations is a necessary prerequisite for the effective organization and reproduction of any macroeconomic system. This problem is particularly relevant in the current conditions of globalization and geopolitical instability.

The purpose of the course “Foreign Economic Activity of an Organization” is to provide future theoretical and practical knowledge in the field of organization, management and legal norms of international business in the context of Russian and world practice.

The main task of the course is to arm master students with practical skills and modern methods of working in foreign markets.

The course includes consideration of a wide range of issues related to the legal, organizational and practical plane of conducting foreign economic activity by Russian and foreign companies.

The method of studying the course is based on a combination of lectures, seminars and practical exercises.

«Internship (Pre-degree Internship)»

«Academic Internship (Research Project; Acquiring Basic Research Skills)»

«Internship (Research Project)»

«State Final Examination»

The State final attestation includes defense of the graduation qualification work. The State final attestation is the last mastering stage of the basic educational program.

The training level of graduates for performance of their professional tasks and compliance of their training with the requirements of the State Standard are assessed in the course of the State final attestation.

«Optical Systems and Components»

The course presents the basic knowledge about the design, principles, calculation and adjustment of various optical systems. Main types of optical systems (telescopes, microscopes, photographic lenses etc.), their special features and general properties are presented. Basic understanding of optical image theory and aberrations is provided. The course also considers main types of the non-imaging optical systems like illumination systems, projectors, various types of interferometers, and basics of optical photometry are explained. In addition, the course presents basic knowledge about optical material science viewpoint of optical-physical and physical-chemical properties used in laser technology, both traditional and non-traditional optical materials. It also contains basic information on the processes of manufacture and control of standard optical components and considers normalized basic parameters of optical materials and technological bases of their production.

«Laser Systems»

Course "Laser systems" contains information about physical fundamentals and design of modern laser systems. Requirements to laser systems, used in science and industry, are analyzed. Main characteristics and technical features of laser systems are presented. Applications of laser systems in industry, environmental monitoring, optical communication and biomedicine are discussed.