National Research Tomsk State University
Double-degree master's programme
«Physics methods and information technologies in biomedicine»

Faculty of Physics

Course Descriptions

Tomsk 2017

Content

Philosophic issues of natural science

Academic year 2016/2017

Date last modified
09.11.2016 10:48

Period
Semester 1

Code
1.1

ECTS credits
2.0

Organizational unit
Tomsk State University

Coordinator
Prof. Demkin Vladimir

Description
The continuous expansion of the horizons of science enriches our knowledge of the world around us. But each scientific advance generates new series of problems and puzzles.
Natural science is a system of scientific knowledge about nature. Practical use of this knowledge was the basis of scientific and technical progress in all spheres of human life. Today, mankind has entered the age of the rule of science, microelectronics, biotechnology, nuclear energy, confirming the great role of the natural sciences in our lives.
Recently, however, the value of scientific knowledge has been increasingly challenged. On the one hand, this is due to a significant decrease in efforts to popularize scientific knowledge. On the other hand this trend is supported by the rise of alternative systems of knowledge, paralleled by the large scale production of unscientific literature that advocates mysticism, parascience, astrology, magic, spiritualism, occultism, etc. These developments undermine the authority of the natural science view of the world, based on rational knowledge.
Under these conditions, the ideals of a scientific and rational relationship to reality acquire great importance. Ignoring the scientific world may lead to dangerous consequences. This danger is magnified when parascience is used in medicine or in politics. There are many examples of how pseudo-representations replace genuine scientific knowledge, emergence of "faith" healers, and the revival of exotic methods of healing. Another example is raising popularity of neovitalism. Hans Driesch, one of the founders of this approach believed that the essence of the phenomena of life is entelechy (a kind of soul), working outside of time and space, and that living matter cannot be confined to a set of physical and chemical phenomena.
Examples of the use of parascience by political power are the inquisition, religious bigotry, fascism, fundamentalism, the tragic consequences of which have been appearing in the media and screens.
These brief examples show that the education of modern specialists in any field of knowledge is impossible without a philosophical understanding of the role of science in life of society.

The module covers the following topics:
- Philosophy and methodology of science.
- Science and humanitarian culture. The scientific method.
- Naturalistic worldview.

- Concepts of modern science.
- Physics of the XXI century. Non-classical methods.
- Modern astronomy.
- Philosophical Problems of Biology.
- Human Genetics and psychophysiology.
- Concept of consciousness in modern science.
- Evolutionary synergetic paradigm of modern science.

Goals
The purpose of this module is to help students form a holistic view of philosophical problems of modern science in the construction of the scientific world. This module is intended to provide a conceptual perception of modern natural science, and introduces the modern scientific world and the principles of scientific thinking.

Instruction language
EN

Prerequisites
Studying the module requires a basic knowledge of physics, astronomy, chemistry, and biology.

Teaching methods
Interactive lectures
Assignments
Work in subgroups

Assessment methods
Seminars
Attendance
Pass/fail exam

Key words
Philosophy and methodology of science, scientific method, naturalistic worldview, concepts of modern science, non-classical methods, synergetic paradigm of modern science.

Special physics practice

Academic year 2016/2017

Date last modified
03.11.2016 14:28

Period
Semester 1

Code
1.2

ECTS credits
5.0

Organizational unit
Tomsk State University

Coordinator
Assoc. Prof. Nyavro Vera, Assistant Pleshkov Maxim

Description
The course covers modern ideas about atoms' structure, allows students to understand the origins and patterns of optical and X-ray spectra, and also promotes the development of skills for using laboratory equipment and handling the results obtained with the use of modern software tools.
The course includes two main parts. The first part introduces the the basic principles of physics and their mathematical expression, basic physical phenomena, methods of observation and experimental research; it teaches to express physics ideas correctly, quantitatively formulate and solve physics issues, evaluate the orders of physics quantities; gives students a clear idea of the limits of physics models and theories' applicability. It also helps students acquire philosophical and methodological issues of modern physics, introduces the history of its development stages, gives students a correct understanding of the role of physics in scientific and technological progress, develops students' curiosity and interest in science, technology and other application issues.
Performing laboratory work will form the skills of experimental work, introduces them to the main methods of physics quantities' accurate measurement, the simplest methods of processing experiment results and basic physics devices.
The second part of the course is devoted to the study of physical approaches in patients' diagnostics and treatment, medical application of modern physical and technical knowledge, using of conventional and modern diagnostics and treatment equipment.
During the practice the students will form the skills used in solving health problems, such as using video reality system for execution of postural tests, applying forceplate method for assessment of pressure center motion. Also the students will get acquainted with the fundamental and applied work principles of conventional and widely used methods of diagnostics and treatment including laser methods, X-rays, radioactivity.

The module covers the following topics:
- General ideas about measurements and control systems in biomedicine.
- Atomic structure and radiation.
- Quantum theory of blackbody.
- Quantum properties of radiation.
- Key provisions of nuclear physics.

- Nuclear radiation.
- Biomedical applications of physical basics.

Instruction language
EN

Prerequisites
Basic knowledge in higher mathematics, mechanics, optics, dynamics of charged particles.

Teaching methods
Interactive lectures
Work in subgroups

Assessment methods
Reports on laboratory work
Attendance
Exam

Key words
Atomic physics, nuclear physics, radiation, radioactivity, atomic structure, laboratory works, virtual reality.

Trends in physics

Academic year 2016/2017

Date last modified
21.11.2016 19:30

Period
Semester 3

Code
1.3

ECTS credits
3.0

Organizational unit
Tomsk State University

Coordinator
Prof. Demkin Vladimir

Description
This module discusses the main directions of development of modern physics knowledge of macro, micro and astrophysics, its influence on the development of medicine and the acquisition of professional skills by medical school students. Particular attention is paid to the application of physics ideas, development of physics methods, devices, technologies and methodologies for the study of the human body, improvement of diagnosis of health conditions, disease prevention and treatment of a patient.
The course concerns the main achievements at the turn of the XX-XXI centuries in the field of solid state physics, plasma physics, lasers, nuclear physics, elementary particles physics and their influence on the development of fundamental and applied medicine.
The course covers the following topics:

- High and low-temperature plasma.
- Accelerators and nuclear medicine.
- Nanomaterials and nanotechnology in medicine.
- Radiation physics and radiation therapy.
- Substance in superstrong magnetic fields.
- Evolution of the Universe. Dark matter and dark energy.

Goals
The purpose of the module is to help students acquire deep and systematic knowledge in the field of modern physics, extending their knowledge base in natural science and biomedicine, enhancing their professional identity.

Instruction language
EN

Prerequisites
Students who wish to take this course are required to have a basic knowledge of physics, mathematics, biology, and information technology.

Teaching methods
Interactive lectures
Assignments
Work in subgroups

Assessment methods
Seminars
Attendance
Exam

Key words
Lasers, accelerators and nuclear medicine, new sources of energy, nanomaterials and nanotechnology in medicine, radiation physics, radiation therapy, nonlinear physics, elementary particle physics, standard model, cosmology, dark matter and dark energy.

History and methodology of physics

Academic year 2016/2017

Date last modified
21.11.2016 18:56

Period
Semester 3

Code
1.4

ECTS credits
2.0

Organizational unit
Tomsk State University

Coordinator
Prof. Demkin Vladimir

Description
The course is intended to give the students a basic knowledge on the history of development, physics and connection with other sciences: philosophy, mechanics, medicine, the emergence of development of scientific knowledge methods, the evolution of the most important physics concepts. The course concerns the main stages of development of physics from ancient times to the present day. The final part of the course discusses the issues and prospects of physics development.
The course covers the following topics:

- Development of the concepts of space and time.
- The methods of scientific cognition.
- Physical picture of the world development.
- Galileo, Newton, and their method of cognition in science.
- The history of development of physics, the use of achievements of physics in medicine.
- Development of ideas about the nature of light.
- The discrete structure of matter. Statistical Physics.
- Successes in nuclear physics, and their use in medicine.
- Role of physical achievements in nature sciences development.

Goals
The purpose of this course to help students acquire deep and systematic knowledge on the major sections and features of modern physics, ideas of the evolution of the most important physics concepts and physics methods, relationship between the various fields of science and the methodology of scientific research in the professional field.

Instruction language
EN

Prerequisites
Studying the module requires knowledge of core courses: General Physics, electrodynamics, quantum mechanics, thermodynamics, statistical physics, having an idea of the mechanical movement relativity,

the theory of heat, the physics field, knowing the structure of matter, atomic structure, theory of light, the basic principles of quantum mechanics.

Teaching methods
Interactive lectures
Assignments
Work in subgroups

Assessment methods
Seminars
Attendance
Pass/fail exam

Key words
Concepts of space, molecular-kinetic theory, wave-particle duality, theory of relativity, modern physics picture of the world.

Organization of scientific activity

Academic year 2016/2017

Date last modified
06.02.2017 16:56

Period
Semester 3

Code
1.5

ECTS credits
3.0

Organizational unit
Siberian State Medical University
Tomsk State University

Coordinator
Assoc. prof. Fokin Vasily
Assoc. prof. Rudenko Tatiana

Description
Students are introduced to the basic concepts of research in biomedicine. The ultimate goal of the course is the development of the skills in organization and planning of scientific research and analysis of the results of biomedical research. Information about the principles of evidence-based medicine and good clinical practice is provided, as it is necessary to evaluate the quality of medical technologies, successful publication and commercialization of research in biomedicine.
The module covers the following topics:

- Organization of scientific activity: achievements, problems, technology.
- Prospects for scientific activities.
- Planning stages of clinical research.
- Evaluation and quality control of medical technologies.
- Analysis of publications on assessing the effectiveness of medical interventions.

Goals
The purpose of this course to help students acquire deep and systematic knowledge about stages of organization of scientific activity, about stages of research in biomedicine. Principles of good practice research are also discussed. The acquired knowledge and skills are relevant to assess the quality of biomedical research.

Teaching methods
Interactive lectures
Lecture-discussion
Work in subgroups

Assessment methods
Seminars
Attendance
Pass/fail exam

Key words
Scientific activity, planning stages of research, medical research ethics, standards of clinical practice.

Current methodology and innovative research in diagnosis, prevention and therapy of disease

Academic year 2016/2017

Date last modified
06.02.2017 17:16

Period
Semester 2

Code
1.6

ECTS credits
6.0

Organizational unit
Siberian State Medical University

Coordinator
Prof. Alifirova Valentina
Assoc. prof. Zhukova Irina

Description
There are the most important issues will be discussed in this course: the latest scientific insights concerning pathogenesis of diseases, the main principals of examination and therapy. More attention will be paid to cerebrovascular, demyelinating diseases and extrapyramidal disorders. This module will allow to get a knowledge about basic neurological examination, practical and theoretical diagnostic methods and their interpretation. The course concerns the main achievements at the turn of the XX-XXI centuries in the field of diagnosis of neurological diseases and their role will be discussed. It will help students to evaluate all information and to make analysis of it. Particular attention is paid to therapy of different neurological diseases.
The module covers the following topics:

- Principles of the structure and functioning of the nervous system.
- Basic syndromes of neurological disorders.
- Fundamental part of examination of nervous system.
- The main principles of diagnosis and therapy of cerebrovascular diseases.
- The main principles of diagnosis and therapy of demyelinating diseases.
- The main principles of diagnosis and therapy of extrapyramidal disorders.
- Achievements at the turn of the XX-XXI centuries in the field of diagnosis in neurology.

Goals
The purpose of the module is to help students acquire deep and systematised knowledge in basic principles of nervous system and neurological diseases.

Instruction language
EN

Teaching methods
Interactive lectures
Work in subgroups

Project
Assessment methods
Seminars
Project report
Attendance
Exam

Key words
Nervous system, gene polymorphism, biochemical, clinical and epidemiological aspects and factors of neurological diseases, clinical symptom of neurologic disease.

Physics fields and forces in biological systems

Academic year 2016/2017

Date last modified
06.02.2017 17:33

Period
Semester 3

Code
1.7

ECTS credits
3.0

Organizational unit
Tomsk State University
Siberian State Medical University

Coordinator
Prof. Tchaikovskaya Olga
Prof. Pekker Yakov

Description
The course allows exploring biophysics basis for the formation of physics fields of tissues, organs and systems of the body. Students study fundamental physics principles of medical diagnostic techniques, methods for controlling the state of the human body, therapy and surgery.
The module covers the following topics:

- Introduction to the course. Physics fields. Basic principles and definitions.
- Biophysics mechanisms of forming physics fields of living systems.
- Receptor systems of the human organism, the transfer of energy, substances and information in biological systems.
- The basic principles of biotechnical systems.
- The interaction of electromagnetic fields with biological tissues and body.
- Exposure of electromagnetic fields in microwave, EHF and terahertz range on living systems.
- Optical fields. Photobiological processes in tissues. Lasers in medicine.
- Ionizing radiation in diagnostic and treatment of living systems. Anatomic and functional imaging.
- Physics principles of medical use of mechanical, barometric effects and acoustic fields.
- Spectroscopic methods in Experimental Biology and Medicine.

Goals
Knowledge of interaction of technical devices, environment and biological object. Students will be introduced to specific examples of biotech systems, establishing compounds' structure, learn to decipher spectra and identify substances, assess the state of biological systems by the of objective physics parameters and characteristics.

Teaching methods
Interactive lectures
Lecture-discussion
Assignments
Work in subgroups

Assessment methods
Reports on laboratory work
Attendance
Seminars
Exam

Key words
Biological object, ultra-violet radiation, infrared radiation, physics field, medical diagnostic techniques, electromagnetic field, microwave, optical field, lasers, medicine.

High-performance computing in biomedicine

Academic year 2016/2017

Date last modified
27.01.2017 11:44

Period
Semester 2

Code
1.8

ECTS credits
4.0

Organizational unit
Tomsk State University

Coordinator
Assoc. Prof. Bogoslovskyi Nikolay
Assoc. Prof. Borisov Alexsey

Description
The course is focused on developing skills in High-Performance Computing systems for solving biomedical issues and ensuring the secure transmission of medical data. The course concerns the choice of technical solutions for High-Performance Computing and organization of computational experiments in a distributed data processing system.
The module covers the following topics:

- Introduction.
- Overview of High-Performance Computing architectures.
- Parallel computing methods.
- Parallel Programming for Multicore Machines Using OpenMP.
- Remote Access Technologies. Infrastructure cloud services.
- Types of cloud services. Theoretical foundations of virtualization.
- Cloud services in the research process.
- High-Performance Computing in medicine and biology. Main areas of application.
- Application of parallel computing algorithms in biomedicine.

Goals
Knowledge and understanding the principles of high-performance supercomputer systems, concepts and terminology of cloud technologies, applications and basic principles of cloud services infrastructure. Applying knowledge and computer technologies to solve the problems of professional activity. Ability to identify the problems of the research in physics and solve them by means of modern equipment and information technologies on the basis of Russian and international experience.

Prerequisites
C\C++ programming language

Teaching methods
Interactive lectures
Assignments

Assessment methods
Assignments
Attendance
Exam

Key words
Parallel Programming, OpenMP, cloud services, High-Performance Computing in medicine and biology.

Methods of measurement and control in biomedicine

Academic year 2016/2017

Date last modified
26.10.2016 18:57

Period
Semester 1

Code
1.9

ECTS credits
3.0

Organizational unit
Tomsk State University

Coordinator
Assoc. Prof. Svetlik Mikhail

Description
The course introduces types of measurement in bio-medicine and their use, developing students' research skills. In the process of studying students will acquire skills in performing continuous multivariate studies with registration, preservation of data and its use for the purposes of management and control in bio-medicine.
The module covers the following topics:

- General ideas about measurements and control systems in biomedicine.
- Classification of biomedical measurement systems, measurement techniques in biomedicine.
- Data storing measurement and visualization of recorded indices.
- Control and monitoring in biomedicine.

Goals
Knowledge o Common ideas about measurement in bio-medicine o Basic concepts of health checking systems in bio-medicine o Classification of biomedical measurements systems o Measurement methods in bio-medicine o General means of biomedical data storage o General means of biomedical data visualization o Management and monitoring tools in bio-medicine.
Understanding o Working principles and structure of the biomedical measurement data acquisition system o Working principles and structure of the biomedical data files.

Instruction language
EN

Teaching methods
Interactive lectures
Work in subgroups
Project

Assessment methods
Reports on laboratory work
Project report

Attendance
Pass/fail exam

Key words
Biological object, power, amplitude, FFT, microprocessor, input output ports, serial port, i2c, data transfer, health checking units, monitoring devices.

Safety of microbiological study

Academic year 2016/2017

Date last modified
27.01.2017 11:11

Period
Semester 2

Code
1.10

ECTS credits
3.0

Organizational unit
Siberian State Medical University

Coordinator
Prof. Karpova Maria

Description
The biological safety in practice is presented to students as follows:
1. Biosafety science links theory and practice of human beings protection against the hazardous biotic factors.
2. Biosafety as an engineering discipline deals with medical, biological, administrative and technical measures to protect staff, population, and environment against biological pathogens.
3. National biosafety as a system of administrative and technical measures is focused on prevention of damage and devoted to achievement a personal, public and state protection against potential and real biological hazards.
The appropriate microbiological technologies together with correct usage of biosafety equipment by the well-trained staff are the main components of biosafety inside the laboratory.

Goals
The course provides students with the knowledge and practical skills in biosafety.

Teaching methods
Interactive lectures
Assignments
Work in subgroups

Assessment methods
Reports on laboratory work
Attendance
Seminars
Pass/fail exam

Key words
Biological safety, biodefense, biological pathogens, potential biological hazards.

Animal models in research

Academic year 2016/2017

Date last modified
20.11.2016 16:00

Period
Semester 2

Code
1.11

ECTS credits
2.0

Organizational unit
Siberian State Medical University

Coordinator
Assoc. prof. Ivanov Vladimir

Description
The course focuses on developing skills for modelling pathological states in animals for studying the physiology and pathology of the organs and systems.
The module covers the following topics:

- International recommendations of biomedical research performed on animals.
- Ethical issues of work on experimental animals.
- Animal welfare and feeding laboratory animals.
- Physiology and animals diseases. Prevention of human diseases.
- Design study. Choice of animals for experiments.
- Simulation diseases on laboratory animals.

Goals
The course introduces students to the principles of performing medical experiments using laboratory animals. Module is important for designing and conducting biomedical and medical research and helpful in designing and conducting preclinical trials of health care products and drugs.

Teaching methods
Interactive lectures
Assignments
Work in subgroups

Assessment methods
Reports on laboratory work
Attendance
Seminars
Pass/fail exam

Key words
Biomedical research, experimental animals, animals diseases, simulation diseases on laboratory animals.

Data analysis in biomedicine

Academic year 2016/2017

Date last modified
22.01.2016 18:23

Period
Semester 2

Code
1.12

ECTS credits
3.0

Organizational unit
Siberian State Medical University

Coordinator
Assoc. prof. Fokin Vasily

Description
The course examines the basic geometric and statistical pattern recognition methods applied to assessing the state of biosystems and making decisions in medicine. In conclusion covers the basics of submission and publication of the results of statistical analysis of biomedical data. The course begins with a discussion of the features of multidimensional biomedical data statistical description.
The module covers the following topics:

- Description and analysis of biomedical data.
- Mathematical methods for decision-making in medicine.
- Publication of the results of the statistical analysis of biomedical data.

Goals
To study the basic mathematical approaches to multidimensional biomedical data analysis and construction of mathematical models for biological systems at various organization levels.

Instruction language
EN

Prerequisites
To take this module students are required to have knowledge of basic concepts of mathematical analysis, vector algebra, probability theory and computer skills.

Teaching methods
Interactive lecture
Work in subgroups
Assignments

Assessment methods
Assignments
Attendance
Exam

Key words
Decision-making in medicine, biomedical data, qualitative data analysis, statistical hypothesis testing.

Molecular basis of health and pathologies

Academic year 2016/2017

Date last modified
03.02.2017 14:19

Period
Semester 2

Code
1.13

ECTS credits
3.0

Organizational unit
Siberian State Medical University

Coordinator
Assoc. prof. Starikova Elena

Description
The course concerns molecular biological diagnostics methods, as well as experimental techniques for biomedical research.
The module covers the following topics:

- Molecular medicine – background, methods and techniques.
- Basis of matrix biosynthesis, gene expression regulation.
- Molecular based experimental techniques.
- Immune system, immunological experimental technics.
- Monogene and multifactor disease.
- Molecular mechanisms of tumours grow. Biomarkers and other early stage diagnosis techniques.
- The main features of the molecular targeted therapy, clinical applications and experimental researches.

Goals
The purpose of the module is to help students acquire deep and systematic knowledge in the molecular mechanisms of health and pathologies by means of an interdisciplinary approach.

Instruction language
EN

Teaching methods
Interactive lectures
Work in subgroups
Project

Assessment methods
Seminars
Project report
Attendance
Exam

Key words
Molecular medicine, biochemical, clinical and epidemiological aspects, immune systemy, monogene and multifactor disease, experimental techniques, molecular mechanisms, clinical applications and experimental researches.

Computing in biomedicine

Academic year 2016/2017

Date last modified
27.01.2016 16:00

Period
Semester 1

Code
1.14

ECTS credits
3.0

Organizational unit
Tomsk State University

Coordinator
Professor Syryamkin Vladimir

Description
The course is focused on developing skills for solving information issues using biomedical high performance computing and synthesis of interdisciplinary knowledge and skills. The course includes basic information about parallel computing algorithms and their application to solve typical issues of data processing in the fields of biology and medicine. The examples and typical tasks are taken from the field of modelling in neurophysiology and medical visualization. The course has a practical orientation and is focused on developing skills of using modern computing systems to meet the challenges of processing large volumes of biomedical data.
The module covers the following topics:

- Introduction.
- Parallel computing. Particularities of programming in the parallel systems.
- The architecture of the modern supercomputers. Particularities of computing with using CPU and GPU.
- Applying of the supercomputers in the biomedicine.
- Processing and visualization of the results of high resolution MRI.
- Mathematical modeling in neurophysiology. Neural networks. Learning algorithms for neural networks. Using of neural networks in pattern recognition and image analysis.
- Applying of the supercomputers in the system biology. The modeling of metabolome.
- Mathematical and statistical processing of large and very large volumes of data.
- Automated analysis and visualization of high resolution mass spectra, statistical processing and detection of disease markers.
- Applying of the supercomputers in pharmacology and design of biologically actives ligands.
- Quantum chemical calculations of the thermodynamics of complexation of organic molecules with biological targets.
- Quantum chemical calculations using parallel systems. Thermodynamics spectra interaction plotting, activity and selectivity evaluation.

Goals
The purpose is focused on developing skills for solving information issues using biomedical high-performance computing and synthesis of interdisciplinary knowledge and skills.

Instruction language
EN

Teaching methods
Interactive lectures
Assignments
Work in subgroups

Assessment methods
Assignments
Attendance
Pass/fail exam

Key words
Parallel computing, supercomputers, interference methods, polarization methods, Interference of polarized rays, rotation of the polarization plane.

Data acquisition and processing systems in biomedicine

Academic year 2016/2017

Date last modified
11.12.2015 12:46

Period
Semester 1

Code
1.15

ECTS credits
5.0

Organizational unit
Tomsk State University
Siberian State Medical University

Coordinator
Assoc. Prof Svetlik Mikhail
Assoc. Prof. Tolmachev Ivan

Description
The course is focused on developing the skills for design and implementation of medical and technical complexes based on physics approaches and interdisciplinary synthesis of knowledge and skills.
The module covers the following topics:

- Classification of the instrumental methods of diagnosis and treatment.
- Instrumental methods of functional diagnostics, biomedical signals.
- Safety requirements for physics treatments, biological protection, security of physics methods of exposure, biological effects of physics fields.
- Instrumental methods of medical visualization, laboratory diagnostics.
- Data features and principles of interaction with the medical equipment device interfaces.
- Structural and functional brain visualization, medical visualization, anatomical, histological medical visualization.
- Electrophysiological methods: Electroencephalography (EEG) and evoked potentials (EP).
- The use of physics fields for therapeutic purposes.
- Organization of interaction between medical equipment and PC, technical implementation of diagnostic and treatment facilities.

Goals
The course provides students with the knowledge and the application of physics methods for solving medical diagnostic issues in modern medicine.

Instruction language
EN

Teaching methods
Interactive lectures
Assignments
Work in subgroups

Assessment methods
Reports on laboratory work
Seminars
Attendance
Exam

Key words
Instrumental methods, functional diagnostics methods, direct methods of functional diagnostics, indirect methods of functional diagnostics, electrophysiological methods, medical imaging techniques, technical realization of medical diagnostic systems.

Laser methods in biomedicine

Academic year 2016/2017

Date last modified
06.02.2017 13:07

Period
Semester 1

Code
1.16

ECTS credits
4.0

Organizational unit
Tomsk State University

Coordinator
Assoc. prof. Telminov Evgenyi
Assoc. prof. Telminov Alexey

Description
The course introduces the basics of the interaction of laser radiation with matter, the physiological effects of laser radiation, and teaches navigate in a variety of methods of laser diagnostics used in biomedicine. The most promising and widely used methods of diagnosis are being analyzed. Particular attention is paid to the physics bases of diagnostic laser applications in biology and medicine. The methods based on the analysis of light scattering and fluorescence are studied thoroughly. The absorption, calorimetric, interferometric and holographic diagnosis methods are also discussed. Laser diagnostic equipment is given a description. As the result of the course students obtain fundamental and applied knowledge of the experimental study principles and of the parameter measurement in optical radiation, as well as of the result interpretation.
The laser diagnostic methods in biomedicine is presented to students as follows:

- The basis of laser physics.
- The fundamentals of interaction of laser radiation with matter.
- The physics principles of nephelometry.
- The physics base of the methods using light scattering characteristics.
- Interferometric and holographic diagnosis methods.
- Absorption and calorimetric diagnosis methods.
- Laser fluorescence analysis.
- Safety when operating with lasers.

Goals
The course provides students with the knowledge and practical skills in laser diagnostic methods in biomedicine.

Teaching methods
Interactive lectures
Assignments
Work in subgroups
Project

Assessment methods
Reports on laboratory work
Project report
Seminars
Attendance
Exam

Key words
Laser, interference, holography fluorescence, laser raman spectroscopy, biological objects, diagnostic methods in biomedicine.

Optical methods in biomedicine

Academic year 2016/2017

Date last modified
22.12.2015 16:00

Period
Semester 2, 3

Code
1.17

ECTS credits
6.0

Organizational unit
Tomsk State University

Coordinator
Prof. Cherepanov Viktor
Prof. Sinitsa Leonid
Assoc. Prof. Karlovets Ekaterina
Assoc. Prof. Petrov Dmitriy

Description
The course focuses on modern optical equipment principles for solving medical issues and developing applications of optics and spectroscopy skills for the analysis of the state parameters of biosystems.
At the end of this module, students will have basic knowledge of how to use a spectroscopic technique and methods for clinical or research diagnostic questions.
The module covers the following topics:

- Introduction.
- Classification methods of optical control and diagnostics in biomedical research: methods of emission-atomic absorption spectroscopy, high resolution absorption molecular spectroscopy methods, luminescence spectroscopy methods, methods of Raman spectroscopy.
- Interference methods. Fundamentals of the interferometers theory.
- Polarization methods. Interference of polarized rays. Birefringence and dichronism phenomenon. Dielectric polarization beams in reflection. Phase plates and compensators.
- The rotation of the polarization plane.
- Artificial anisotropy.
- Kerr cell.
- Cotton-Mouton effect.
- Testing devices of biological materials and coatings. Polarimeter and polariscope.
- Laboratory practical class on biomedical optical diagnostics.

Goals
Familiarity with the modern state of recording devices and generating optical radiation, focused on application in biomedicine, the formation of notions about the principles of optical methods' impact on biological objects, the development of practical skills in using optical methods and optical equipment for the needs of medical diagnostics.

Instruction language
EN

Prerequisites
To study this module, the students are required to have knowledge of basic concepts of mathematical analysis and general physics, and of quantum theory.

Teaching methods
Interactive lectures
Work in subgroups

Assessment methods
Reports on laboratory work
Attendance
Exam (Semester 2)
Pass/fail exam (Semester 3)

Key words
Optical and spectroscopic techniques, emission spectroscopy methods and atomic absorption, methods of molecular absorption and fluorescent spectroscopy, radiation, biosystems, photodynamic therapy.

Research

Academic year 2016/2017

Date last modified
06.02.2017 18:15

Period
Semester 1, 2, 3, 4

Code
2.1

ECTS credits
42.0

Organizational unit
Tomsk State University
Maastricht University

Coordinator
Research supervisor(s)

Description
Research is an obligatory component of Module 2 Practical Trainings Including Research of the individual study plan of a Master's Student.
Tasks in Research are as follows:

- to develop professional research and scientific thinking in Master's Students and their understanding of basic professional tasks and means of solution;
- to study modern research methods using latest equipment and computing means;
- to search, process, analyze, and systematize scientific data on a research topic; to select methods and means to solve the tasks;
- to develop competencies in accordance with the types and tasks of professional activity.

The Research covers the following stages:

- Preparatory stage:
  - approving the topic;
  - setting objectives and tasks in research;
  - identifying an object and subject of research;
  - developing a working hypothesis;
  - studying special and other scientific and technological literature.
- Selection and study of research methods:
  - studying research methods;
  - developing physics and mathematical/physics model;
  - planning experiment.
- Independent research
- Analysis
  - processing, analyzing, arranging, summarizing information on research topic.

Goals
Research goals to strengthen and broaden knowledge and competencies relevant to the types of activities, develop skills at independent research in Master's Students.

Teaching methods
Consultations
Assignments
Research experiment

Assessment methods
Report at the meeting of the Department
Written or oral report in the presentation format at the meeting of the Department
Reports presented to supervisors at scientific seminars (monthly, by webinar)
Pass/fail exam
Pass/fail exam
Pass/fail exam
Graded exam

Key words
Professional research, modern research methods, equipment, computing means, developing physics and mathematical/physics model, research experiment.

Pre-graduation practice

Academic year 2016/2017

Date last modified
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Period
Semester 4

Code
2.2

ECTS credits
12.0

Organizational unit
Tomsk State University
Maastricht University

Coordinator
Research supervisor(s)

Description
Completion of the programme of pre-graduation practice reveals the level of master's students' skills in relation to the types of activity the Master's Programme is oriented to.

Tasks in pre-graduation practice are as follows:
- to deepen and broaden acquired knowledge;
- to strengthen competencies related to the profile of the Programme;
- to collect and process experimental and empirical data;
- to develop analytical and organizational skills;
- to prepare and write Master's Thesis.

The practice covers the following stages:
- Processing and analysis of research results:
  - selection and systematization of results;
  - processing, analysis, assessment of the effectiveness of results;
  - preparation of the text of a Master's Thesis;
  - submission of results to a research supervisor.
- Reporting: preparation of reporting documents on the results of pre-graduation practical training.

Goals
Pre-graduation practice goals to obtain theoretical and practical results sufficient for successful completion of a Master's Thesis (FQP) and its defence.

Teaching methods
Consultations
Assignments

Assessment methods
Reports at scientific seminars

Report as a pre-defence of Master's Thesis at the meeting of the Department
Graded exam

Key words
Acquired knowledge, analytical and organizational skills, experimental and empirical data, Master's Thesis.