MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
NATIONAL RESEARCH
TOMSK STATE UNIVERSITY

FACULTY OF PHYSICS

APPROVED BY

Dean of the Faculty of Physics

_____O. N. Tchaykovskaya

01.09 _____20 16

Programme of Practical Training

Research

subject area
03.04.02 Physics

Profile
Physics Methods and Information Technologies in Biomedicine

Degree
Master of Science

Mode of study
Full-time

Tomsk-2016

1. Objectives of practical training

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

2. Tasks in practical training

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, analyse, and systematise 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.

3. Integration of practical training into the structure of the BEP

Research is an obligatory component of Study block 2. Practices, including research of the individual study plan of a Master's Student.

Research is conducted during the entire studying. In the first semester, Research takes place along with such disciplines as *Philosophic Issues in Natural Science, Computing in Biomedicine, Laser Methods in Biomedicine, Methods of Measurement and Control in Biomedicine,* and *Data Acquisition and Processing Systems in Biomedicine* that introduce current methods for organising scientific studies with bio-objects to students.

In the first semester, students studying on the Double-Degree Master's Programme *Physics Methods and Information Technologies in Biomedicine* carry out their research in Tomsk State University, in the second semester they do it in Maastricht University (The Netherlands). Moreover, Master's Theses are guided by two supervisors: one from TSU and another one from the UM.

Therefore, to successfully complete their research Master's Students must:

Know:

- topical issues in biomedicine;
- advanced methods of measurement, control, and processing of data in biomedicine;
- basics of arranging research and project activities in a team;
- spheres of professional self-development.

Can:

- analyse current tasks in research;
- collect and process information using modern software and technologies;
- independently study new research methods;
- independently set objectives in research in a particular branch of physics;
- apply knowledge of current issues and latest achievements in physics to practice and estimate their efficiency;

Master:

- methodology of scientific approach;
- team work;
- skills at planning and statistical analysis of results of biomedical research.

Research practice is important since it allows Master's Students to acquire knowledge and skills that will be further required to prepare their Master's Theses during pre-graduation practice.

4. Types of practical training

Research is a university-based practical training.

5. Forms of practical training

Research can be held as a laboratory or project activity by engaging students into current research and scientific projects relevant to the BEP provided by both TSU and its partners.

Master's Student has the right to independently select a research topic agreeing it with research supervisors at Tomsk State University and Maastricht University.

6. Places and terms of practical training

Research can be held in the Laboratory of General and Experimental Physics at TSU and laboratories of partner universities (Maastricht University, Siberian State Medical University).

Terms of completion are determined by the curriculum (semesters 1-4).

7. Learning outcomes of the practical training correlated with the learning outcomes of the BEP

Developed competencies	Learning outcomes
GC-1, level II ability for abstract thinking, analysis and synthesis	C (GC-1) –II CAN process collected information, assess personal knowledge and general culture within the context of social processes and setting goals of individual intellectual development
GC-2, level II ability to act in unusual situations and bear ethical and social responsibility for decisions	C (GC-2) – II CAN define the idea and meaning of conducted procedures, develop plan for correcting problem situation in research and project, contribute to the development of fully-fledged partnership between team members; M (GC-2) – II MASTER methods for arranging and conducting activities in professional sphere based on moral values and legal standards accepted in the society
GC-3, level II ability for self-development, self-realization and use of creative potential	C (GC-3) – II CAN independently study new methods of research and adapt to solving new practical tasks
GPC-1, level II ability to communicate both orally and through the written word in the official language of the Russian Federation and other languages to solve the problems of professional activity	C (GPC-1) –II CAN communicate in a foreign language in the scientific community M (GPC-1) –II MASTER skills at oral presentation and defence of research results
GPC-2, level I ability to guide a team in their professional activity being tolerant of social, ethnic, confessional and cultural differences	3 (GPC-2) –I KNOW fundamentals of organising group research and projects and management C (GPC-2) – I CAN identify critical situations emerging in the course of research and project M (GPC-2) –I MASTER basics of team work, project management, and methods for influencing a team
GPC-3, level I ability for social mobility and organization of research and innovative works	K (GPC-3) –I KNOW potential spheres and directions for professional self-development, the main theories and methods of adjacent field of knowledge and

	types of professional activity in particular, means of reaching high standards of professional and personal development C (GPC-3) –I CAN identify and set goals for personal and professional development and conditions to achieve these goals according to the stages of professional growth and requirements of labour market for specialists, formulate scientific problems in professional activity
GPC-4, level I ability to adapt to a new scientific field of professional activity, sociocultural and social conditions of the activity	K (GPC-4) –I KNOW promising directions in modern science C (GPC-4) –I CAN formulate a scientific problem in a professional sphere, identify possibilities of changing the profile of professional activity
GPC-5, level II ability to use professionally-oriented knowledge and computer technologies to solve professional tasks including those that are not related to the major (profile) of a training	C (GPC-5) –II CAN use method and means for obtaining, storing, processing, and translating information by means of the latest information technologies including global computer networks
GPC-6, level II ability to apply knowledge of modern problems and latest achievements in physics to research work	C (GPC-6) –II CAN apply knowledge of current issues and latest achievements in physics to practice and estimate their efficiency M (GPC-6) –II MASTER methodology of research and scientific and practical activity, skills at developing competencies and knowledge
PC-1, level II ability to identify specific tasks of physics studies and solve them by means of modern equipment and information technologies based on domestic and international experience	C (PC-1) – II CAN independently set correct tasks in research in a selected branch of physics, solve them using modern equipment, information technologies and latest domestic and international experience
PC-4, level I ability to plan and organize physics studies, scientific seminars and conferences	K (PC-4) –I KNOW principal methods and techniques for making managerial decisions C (PC-4) – I CAN independently find and make managerial decisions using legal documents
PC-5, level I ability to use skills in designing technical documentation, reports, reviews, papers and articles	C (PC-5) –I CAN extract information from various sources including periodicals and e-communications M (PC-5) – I MASTER skills at extracting information from various sources for study and research
SPC-1, level I understanding of the basic neurology, the fundamentals and practice of medical diagnosis and therapy	C (SPC-1) –I CAN navigate in the latest achievements in diagnosis of neurological disorders

SPC-2, level I knowledge of basics of gene regulation, the fundamentals and practice of molecular diagnosis and therapy	C(SPC-2) –I CAN navigate in the latest achievements in molecular diagnosis
SPC-3, level I knowledge of the main methods to determine molecular targets and their applications in biomedical diagnosis	C(SPC-3) –I CAN navigate in the latest achievements in biomedical diagnosis
SPC-6, level I ability to use software for statistical analysis of multidimensional biomedical data in evaluation of the state of biosystems	M (SPC-6) – II MASTER basic skills at planning and statistical analysis of results of biomedical studies
SPC-8, level I practical skills at obeying safety rules in a potentially hazardous laboratory environment	C (SPC-8) –I CAN ensure biological safety when working in research laboratories

8. Workload of the practical training is 42 ECTS-Credits.

9. Pre-graduation practical training lasts 1,512 academic hours.

10. Content of the practical training

No	Sections (stages)	Types of research and workload (in hours)			Forms of formal control
		Total	Classroom	Students' independent work	
1	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	310	60	250	Master's Student's individual study plan. Report at the meeting of the Department For report: – introduction to research topic; – literature review; – plan-schedule of work on the dissertation
2	Selection and study of research methods: – studying research methods; – developing physics and mathematical/physics model; – planning experiment	310	60	250	Written and oral report in the presentation format at the meeting of the Department. For the report: – Materials of Chapters 1 and 2

3	Independent research	445	195	250	Reports presented to supervisors at scientific seminars (monthly, by webinar). Report at the meeting of the Department
4	Analysis Processing, analysing, arranging, summarising information on research topic. Preparing scientific publications, paper presentations (if possible)	447	195	252	Written or oral report in the presentation format at the meeting of the Department
	Total	1,512	510	1,002	

11. Forms of reporting

Results of Master's Student's research serve as a basis for writing a Master's Thesis. Research results are:

- approved topic of a Master's Thesis and plan-schedule of work on the dissertation reflected in the Master's Student's individual study plan specifying the main activities and terms of completion; setting goals and tasks in research;
- identification of an object and subject of research; reasons for topicality of the topic and description of the problem; description of methods; selection and study of the literature that will be used in a theoretical part of the Thesis;
- thorough literature review on the research topic that is based on topical research publications and contains the analysis of the main results and provisions obtained by leading specialists in the sphere of conducted research, estimation of their use within the research and author's contribution to the topic. Literature review must be based on sources revealing theoretical aspects of the studied question, first and foremost, monographs and papers in scientific journals;
- collected factual material for the Master's Thesis including a developed methodology for data collection;
- analysis and systematisation of information on the research topic.

Examination of a Master's Student with submission of mid-term result of research is held in the formats specified by the individual study plan. The main formats are report to a research supervisor, report at the meeting of the Department according to the results of completion of research at the end of each semester.

Examination in the first semester is in the presentation format at the meeting of the Department.

Examination in the second semester is held in the form of an oral report and presentation made at the meeting of the Department. Master's Students are awarded pass or fail according to the results.

Examination in the third semester is held in the form of reports at scientific seminars (monthly) or in the webinar format. Master's Students are awarded pass or fail according to the report presented at the meeting of the Department.

Examination in the fourth semester is held in the form of an oral or written report in the presentation format at the meeting of the Department (graded pass/fail exam).

Research results can be presented in paper presentation on a scientific conference/seminar, publication in a scientific journal indexed in the databases of Web of Science and Scopus according to Master's Students' individual study plans.

12. Assessment tools for mid-term assessment of Master's Students' progress in research practice (see Assessment Tools for Practical Training)

13. Teaching and learning materials and information support of practical training

a) main references:

1. Gerasimov B., Drobysheva V. Osnovy nauchnykh issledovanij [Fundamentals of research]. Moscow. – 2015. – 272 p. [RUS]

2. Mokij V., Nikiforov A. Metodologija nauchnykh issledovanij [Methodology of research]. Moscow. – 2016. – 255 p. [RUS]

3. Shashenkova E.A. Issledovatelskaja dejatel'nost' [Research activity]. Moscow: Perspektiva. – 2010. – 88 p. [RUS]

4. Protsess podgotovki, razrabotki, napisanija i oformlenija vypusknykh kvalifikatsionnykh rabot (VKR): urovni podgotovki: bakalavr, magistr, spetsialist: po raznym napravlenijam podgotovki [Preparing, developing, writing, and designing theses (FQP): Bachelor's, Master's, Specialist's Degrees in different subject areas]. Tomsk State University, Academic Office, Department of Standardization, Metrology, and Quality Control of R&D. A.S. Revushking, I.V. Ivonin. Tomsk. – 2014. [RUS]

5. Chen C. Searching for intellectual turning points: Progressive knowledge domain visualization [Electronic resource] // Proceedings of the National academy of sciences of the United States of America. – 2004. – Vol. 101, suppl. 1. – P. 5303–5310. – The electronic version of the printing publication. – URL: http://www.pnas.org/content/101/suppl_1/5303.full.pdf (access date: 22.11.2016).

6. Regehr G. Trends in medical education research [Electronic resource]// Academic medicine. – 2004. – Vol 79, is. 10. – P. 939–947. – Electronic version of printing publication. – URL : http://journals.lww.com/academicmedicine/Fulltext/2004/10000/Trends_in_Medical_Education_Research.8.aspx

b) additional references:

7. Blackford S. Career planning for research bioscientist [Electronic resource] / S. Blackford. – Chichester : Wiley, 2012. – 194 p. – The electronic version of the printing publication. – URL: https://ebookcentral.proquest.com/lib/tomskuniv-ebooks/detail.action?docID=1022741 (access date: 22.11.2016).

8. The institution of science and the science of institutions : the legacy of Joseph Ben-David / ed. by M. Herbst. – Dordrecht : Springer Science+Business Media, 2014. – (Boston Studies in the Philosophy and History of Science). – Electronic version of printing publication. – URL: http://link.springer.com/book/10.1007/978-94-007-7407-0 (access date: 25.11.2016).

9. Minguillo D. Toward a new way of mapping scientific fields: authors' competence for publishing in scholarly journals [Electronic resource] // Journal of the Association for Information Science and Technology. – 2010. – Vol. 61, is. 4. – P. 772–786. – The electronic version of the printing publication. – URL: http://onlinelibrary.wiley.com/doi/10.1002/asi.21282/full (access date: 22.11.2016).

10. Hyland K. Scientific writing [Electronic resource] / K. Hyland, F. Salager-Meyer // Annual review of information science and technology. – 2008. – Vol. 42. – P. 297–338. – The electronic version of the printing publication. – URL: http://onlinelibrary.wiley.com/doi/10.1002/aris.2008.1440420114/pdf (access date: 22.11.2016).

11. Baker D. P. Teamwork as an essential component of high-reliability organizations [Electronic resource] / D. P. Baker, R. Day, Eduardo Salas // Health Research and Educational Trust. – Vol. 41, is. 4p2. – P. 1576–1598. – The electronic version of the printing publication. –

URL: http://onlinelibrary.wiley.com/doi/10.1111/j.1475-6773.2006.00566.x/epdf (access date: 22.11.2016).

12. Petrova N., Akulin A. Obosnovanie dizaina nauchnogo issledovaniia i osnovnye metody analiza rezultatov issledovanija [Reasoning for design of research results and principal methods of statistical analysis of research results]. Moscow. – 2014. – 48 p. [RUS]

13. Avdeenko A.M., Kudrja A.V., Sokolovskaja E.A. Nauchno-issledovatel'skaja rabota studentov [Research and scientific activity of students]. Teaching and learning book. Moscow: MISiS. – 2008. – 78 p. [RUS]

14. Vaindorf-Sysoeva M.E. Tekhnologii ispolnenija i oformlenie nauchno-issledovatelskoj raboty [Technology for writing and designing research papers]. Teaching and learning book. Moscow: TsGL. – 2006. – 96 p. [RUS]

15. Sal'nikova T.P. Issledovatelskaja dejatelnost' studentov [Students' research activity]. Teaching and learning book. Moscow: Sfera. – 2005. – 96 p. [RUS]

c) software and Internet resources:

1. Federal portal *Russian Education* URL: http://www.edu.ru/.
2. TSU Research Library URL: http://lib.tsu.ru/ru/node/1290.
3. Information and educational portal *e-Journals* URL: http://www.eduhmao.ru/info-.
4. e-Library of dissertations URL: www.diss.rsl.ru.

14. Equipment and resources

Equipment and resources are provided by the departments organizing research (laboratories of the Department of General and Experimental Physics, laboratories of Maastricht University and Siberian State Medical University).

Maastricht University provides research laboratories working in numerous directions and equipped with modern experimental equipment such as MRI-scanners, electronic microscopes, thermal imaging cameras, magnetic stimulators of neural activity, 3D-printers, etc.. All the equipment can be used by students to do research.

There are two libraries at Maastricht University. They provide students with the access to printed materials and e-resources. Each library is equipped with special places for both individual and group work. There are computers with the access to local and global network.

To process empirical data and prepare Master's Thesis, students can use the Laboratory for Modelling Physical Processes in Biology and Medicine (TSU, building 2, room 422). The laboratory is equipped with an interactive board, sound and video equipment, multimedia equipment to make presentations, and other learning materials. There are PCs with the Internet access. The room has a local network to enable data transfer between students.

TSU Research Library provides Master's Students with an open access to its resources. On 1 January 2016 the fund of Research Library made up 3,835,710 units. Users are provided with online access to a wide range of remote and local databases of research and educational resources: 67 full-text databases including e-library and e-catalogue of Tomsk State University. Full-text databases provide access to 10,000 full-text journals (mostly international) with archives, 170,000 books, 2.9 mln dissertations, reviews, and statistical, analytical and other materials. The databases of Scopus, Web of Science, e-Library, resources of Springer, journals published by Elsevier, Oxford University Press, East View, Polpred, JSTOR are widely used. High-speed Internet is provided.

15. Supervisor of practical training

Master's Students' research practice is guided by supervisors of their Master's Theses.

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Approved at the meeting of Teaching and Learning Committee of the Faculty of Physics. Minute No 6-16 dated 30.06.2016

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ASSESSMENT TOOLS FOR
practical training

RESEARCH

subject area
03.04.02 Physics

Profile
Physics Methods and Information Technologies in Biomedicine

Degree
Master of Science

Mode of study
Full-time

Tomsk–2016

12. Assessment tools for mid-term assessment of Master's Students' progress in research practice (see Assessment Tools for Practical Training) include:

List of graduates' competencies developed within research practice:

(GC-1) (Level II): ability for abstract thinking, analysis and synthesis;

(GC-2) (Level II): ability to act in unusual situations and bear ethical and social responsibility for decisions;

(GC-3) (Level II): ability for self-development, self-realization and use of creative potential;

(GPC-1) (Level II): ability to communicate both orally and through the written word in the official language of the Russian Federation and other languages to solve the problems of professional activity;

(GPC-2) (Level I): ability to guide a team in their professional activity being tolerant of social, ethnic, confessional and cultural differences;

(GPC-3) (Level I): ability for social mobility and organization of research and innovative works;

(GPC-4) (Level I): ability to adapt to a new scientific field of professional activity, sociocultural and social conditions of the activity;

(GPC-5) (Level II): ability to use professionally-oriented knowledge and computer technologies to solve professional tasks including those that are not related to the major (profile) of training;

(GPC-6) (Level II): ability to apply knowledge of modern problems and latest achievements in physics to research work;

(PC-1) (Level II): ability to identify specific tasks of physics studies and solve them by means of modern equipment and information technologies based on domestic and international experience;

(PC-4) (Level I): ability to plan and organize physics studies, scientific seminars and conferences;

(PC-5) (Level I): ability to use skills in designing technical documentation, reports, reviews, papers and articles;

(SPC-1) (Level I): understanding of the basic neurology, the fundamentals and practice of medical diagnosis and therapy;

(SPC-2) (Level I): knowledge of basics of gene regulation, the fundamentals and practice of molecular diagnosis and therapy;

(SPC-3) (Level I): knowledge of the main methods to determine molecular targets and their applications in biomedical diagnosis;

(SPC-6) (Level I): ability to use software for statistical analysis of multidimensional biomedical data in evaluation of the state of biosystems;

(SPC-8) (Level I): practical skills at obeying safety rules in a potentially hazardous laboratory environment.

- Maps of competencies developed within research are provided in Annex 1.
- System of assessment:

Structure of assessment

1.	Presentation of mid-term results at seminars of a scientific group (at least 3 scientific seminars)	30%
2.	Report on research	70%

- Assessment tools

Assessment tools for the outcomes of the practical training encompass questions on reasoning the choice of a research topic, literature review and conclusions based on the literature, specifics of techniques for data acquisition and processing. Students are asked the questions during the seminars of a scientific group/meeting of the Department or discussion of the results with a supervisor.

Sample questions asked at the defence of research practice

1. Description of a research subject.
2. Research problem.
3. Development of working hypothesis.
4. Selection of research methods.
5. Experimental equipment and mathematical software packages used in research.
6. Preparation and conduction of experimental part.
7. Structure of work: summative experiment (testing), formative or transforming experiment (constructing), and control experiment.
8. Work with scientific literature, technical and technological documents.
9. Creation of a physics and mathematical/mathematical model. Reasons for using the model.
10. Methods for processing and interpreting experimental results and comparing them with the results of modelling.
11. Comparison of the facts obtained in the experiment with results of other authors (they can match or contradict).
12. Evaluation of reasons for discrepancy of results (conditions, age, heterogeneous respondents, insufficient duration of the experiment, etc.).
13. Perspective or scientific theory, or concept results can be explained from.
14. Make conclusion on approval/disproval of the working hypothesis.
15. Individual results in percentage.
16. Principal research results.
17. Feasibility of research.
18. Main practical recommendations.