საქართველოს ტექნიკური უნივერსიტეტი
GEORGIAN TECHNICAL UNIVERSITY

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Doctoral Educational Program

Program Title

ბიოსამედიცინო ინჟინერია
Biomedical Engineering

Faculty

ინფორმატიკის და მართვის სისტემები
Informatics and Control Systems

Program Supervisor

Professor Irine Gotsiridze

Qualification to be Awarded

Doctor of Engineering Will be awarded in case of covering not less than 180 credits of an educational program.

The Language of Teaching

English

Admission Prerequisites to the Program

Master of Scienses (MSC) or equalized diploma.
Applicants must meet the following requirements:

- A person must have a master or equalized academic qualification in the field of related sphere, in particular in electronic engineering, chemical engineering, medical physics, physics, computer engineering, computer science or related specialties.
- An applicant must know English – s/he must take an exam at GTU Testing Centre or must present an international certificate confirming the knowledge of English on B2 level. Applicants who have acquired education abroad or have undergone foreign language programs, are not required either to take exams or to present the certificates.
- Scientific publications and/or successful participation in scientific conferences will be taken into account.
- Applicants will be interviewed by the temporary commission members of the faculty. Preconditions of the admission to the program will be transparent. The information about the admission will be available for students and other interested parties on the web-sites of the University and the Faculty of Informatics and Controls Systems.

http://gtu.ge/Ims/pdf/Edu-Programs/doqtorantura_biosamedicini_injineria_eng_2018.pdf

Description of the program

The program is set up using ECTS system. 1 credit is equal to 25 hours, implying both contact and independent work hours. The distribution of credits is presented in the curriculum. The program duration is 3 years (6 semesters) and includes 180 credits (ECTS). Courses - 35 credits, thematic seminars - 25 credits, research component - 120 credits. Each semester consists of 15 weeks, the dates of mid-semester and final / additional examinations are defined at the beginning of each year by the rector's order based on the instruction of the learning process schedule.

Learning process of the first-year is allocated as follows:
In the first semester of the first year of studies, students will cover: Scientific Communication Techniques (4 credits), Teaching Methods and Education Management (6 credits) and special courses (mandatory and elective - 10 credits) related to the doctoral program. In the same semester students prepare a thematic seminar - 1 (10 credits)
In the second semester students cover the following courses: Biomedical Engineering Research Methods (5 credits), and mandatory and elective special courses related to the doctoral program (10 credits). PhD students prepare thematic seminar - 2 (15credits). The presentation of the outcomes of the research and the defense of the thesis of thematic seminar takes place in front of the audience.

Learning process of the second year: In the third and fourth semesters PH.D students are required to prepare two colloquiums. The first semester is dedicated to the preparation of colloquium 1 (30 credits), the second semester – to the preparation of Colloquium - 2 (30 credits). The colloquium represents the outcomes of the research carried out by the student and is a part of dissertation.

Learning process of the third year: Completion and defense of the thesis (60 credits**).** Completion and defense of the thesis is a major part of the research component. The completed dissertation should be an independent scientific research work and should demonstrate the scientifically substantiated new results of the theoretical / experimental research conducted by the Ph.D. student. The assessment of the thesis is done once, final assessment is done by the members of the university dissertation board on the basis of public defense, the maximum point is 100.
The course or research component credits collected in foreign accredited partner Universities are recognized in accordance with the special decree of the Academic Council of the University.

The prerequisite for the defense of the Ph.D thesis (together with other requirements determined by the regulation of PH.D studies) is the preliminary defense of the dissertation thesis at the expanded session of the academic department, and after the submission of the documents by a PH.D student to the Dissertation Board, the dissertation is checked for plagiarism.
Detailed information about PH.D studies can be found at the web-site of Georgian Technical University in the

following documents:

Regulation of PH.D studies at Georgian Technical University;
http://gtu.ge/Learning/pdf/doqtoranturis_debuleba_29.05.18.pdf

Learning and research components of PH.D educational program and the instructions of their assessment.

http://gtu.ge/Learning/pdf/doqtoranturis_danarti_2_2018_2.pdf

http://gtu.ge/Learning/pdf/doqtoranturis_danarti_3_06.2018.pdf

Web page of the Educational Program
http://biomedeng.gtu.ge/programebi.html
https://bmegtu.wordpress.com

Program Objective

The objective of PhD program is to prepare qualified specialists and researchers in the sphere of biomedical engineering with the skills of innovative research and teaching methods who will be competitive on both inner and international labor markets. Oriented on the study and development of new technologies in the sphere of biology and medicine, the program graduates will be able to work on the technologies of biotechnical systems, rehabilitation engineering, medical instrumentation systems, electronic healthcare systems (the so-called HIT systems). The ultimate goal of the program is to prepare the specialists who will have high professional and academic standards in the field of biomedical engineering and will be able to adapt with and integrate into multidisciplinary, international environment in order to implement the scientific research processes.

The Learning Outcomes/Competence (general and field-specific)

Knowledge and understanding:

- The ability to determine new approaches in the sphere of biomedical engineering, the base of which will be knowledge, innovative methods and technologies in the mentioned sphere;
- Knowledge based on recent achievements in the methods and modeling of scientific research work and in the theories of exact and approximate calculation;
- Knowledge of setting and solving the tasks connected with software and hardware for biotechnical medical systems;
- Knowledge of selecting the methodology and principles which will be relevant to research;
- Understanding the necessity of new, contemporary and original ways of solving problems;
- Understanding of the professional and ethic responsibility in the process of decision making in the sphere of biomedical engineering and in ensuring a high standard of health care for the community;

Applying knowledge:

A person having the academic degree of a doctor in biomedical engineering will be able to use knowledge in practice, in particular:

- Oriented on the creation of new knowledge s/he will be able to plan, implement and supervise applied and fundamental researches independently, develop medical systems, information technologies of healthcare and new research and analytical methods of working on medical equipment;
- Will be able to analyze, synthesize and evaluate innovative ideas and research outcomes thoroughly and for specific reasons; will mould the criteria for new bio-technical medical equipment and make decisions oriented on research studies; will be able to formulate and utter individual reasoned ideas about the problems under discussion.

Making judgments:

• Doctor of Biomedical Engineering will be able to synthesize existing knowledge and generate new knowledge in the field;

• Orientated on scientific and pedagogical activity, s/he will be able to develop new methodology for studies and to elaborate training aids for laboratory and practical tasks;
• The Doctor of Biomedical Engineering will be able to find innovative ways for solving the problems and make scientifically substantiated decisions;
• On the basis of thorough analysis of complex problems in the field of biomedical engineering, s/he will be able to elaborate valuable recommendations, conclusions and hypothesis.

Communication skills:
Resulting from the specificity of Biomedical Engineering, a person with an academic degree of a doctor will be able to communicate with wide audience and have skills of work in a group, in particular, s/he will have the following skills:
• ability to present their ideas and research findings appropriately to the public and the scientific community both in written and oral form;
• ability of getting and disseminating the latest information by the help of different communication means;
• ability to work easily with big databases;
• ability to understand complex, extensive texts and decode the information conveyed in them;
• ability to freely engage in a theoretical discussion with the professionals working in the multidisciplinary field worldwide;
• ability to achieve independently international recognition of their reasoning and research outcomes;
• have high scientific communication skill;

Learning skills:
• carrying on and mastering independent studies of theoretical and experimental literary sources provided by Ph.D program, determining further stages of studying modern methods and estimation of future activity on the basis of acquired knowledge;
• determining the direction of studies, planning the learning process, carrying on studies independently and creatively on the basis of understanding the specificities of the learning process; applying the strategies of constant renewal of knowledge; enhancing professional knowledge independently by means of special literature and electronic resources.

Values:
• develop academic responsibility to the public and scientific circles;
• develop devotion to modern Western values based on the activity in University environment;
• in the environment of studies and research develop individual and professional values corresponding to high moral standards of national and international community;
• develop the ability of observing the norms of scientific ethics, of excluding plagiarism and developing the sense of responsibility to the object of research.

Methods (teaching - learning) of Achieving Learning Outcomes

☒ Lecture ☒ Seminar (working in groups) ☒ Practical class ☒ Laboratory ☒ Scientific thematic seminar ☒ Independent work ☒ Consultation ☒ Research component ☒ Formalizing of the dissertation
☒ Defense of the dissertation

Teaching and Learning Methods:
1. **Discussion/debates.** This is the most widely spread method of interactive teaching. A discussion process greatly increases the quality of students' involvement and their activity. A discussion may turn into an argument and this process is not merely confined to the questions posed by the teacher. It develops students' skills of reasoning and substantiating their own ideas.
2. **Collaborative work**; using this method implies dividing students into separate groups and giving each group its own task. The group members work at their issues individually and at the same time-share their opinions with the rest of the group. According to the problem raised, it is possible to shift the functions among the group members in this process. This strategy ensures the students' maximum involvement in the learning process.
3. **PBL**- The method, which is the initial stage of the process of integration of new knowledge and uses a concrete problem

4. **Heuristic method** - based on a gradual solution to a given problem. The facts in the teaching process and the links between them is realized by means of independent fixing

5. **Analyses Methods –** help us to divide the united material into its components parts. It facilitates to identify separate problems.

6. Verbal method comprises a lecture, narration, conversation, etc. During the process the teacher conveys, explains the material verbally, and students perceive and learn it by comprehending and memorizing.

7. Writing Method – it means the following actions: to make extracts and records, to make conspectus, to write theses, to write abstracts or essays, etc.

8. Laboratory Method - implies the following activities: conducting experiments, video materials, and materials with dynamical characteristics and others.

9. Practical Methods – unites all students' studying practical skills developing spheres. In this case, student acts independently, for instance, pedagogical and industrial practice, fieldwork etc.

10. Explanation Methods –is based upon the given task. Teacher handing out the materials gives concrete examples and then they discuss them in details in the given topic sphere.

11. Brainstorm (Brainstorming) - This method involves a specific topic within a specific issue / problem to many radically different opinions, to express the idea of the establishment and its promotion. This method contributes to the problem of developing a creative approach. This method is effective in a large group of students and consists of the following stages:

12. Project Development and Presentation -during the development of the project student uses the gained skills to solve a specific problem. Learning through the projects develops student's motivation and responsibilities. Project working consists of planning, the stages of result presentations and practical activities according to the chosen task. Project is successfully carried out if its results are presented firmly in practical way. It may be carried either individually or in-group; it may refer to one or several fields; after the fulfillment of the project, it will be presented to a wide audience.

Based on the specifics of a concrete course, the appropriate activities of teaching/learning methods listed below are employed, reflected in the relevant learning course programs (syllabi).

Student Knowledge Assessment System

Grading system is based on a 100-point scale.

Assesmeent of learning component:

Positive grades:

- **(A)** - Excellent - the rating of 91-100 points;
- **(B)** – Very good - - the rating of 81-90 points
- **(C)** - Good - the rating of 71-80 points
- **(D)** - Satisfactory - the rating of 61-70 points
- **(E)** - Enough - the rating of 51-60 points

Negative grades:

- **(FX)** - Did not pass - 41-50 points of rating, which means that the student needs more work to pass and is given the right to take the exam once more with independent work;
- **(F)** – Failed - 40 points and less, which means that the work carried out by the student is not enough and he/she has to learn the subject from the beginning.

Assesmeent of the Learning Course of Doctoral Program

Each form and component of the evaluation from the general point of assessment (100 points) is defined in the final assessment. In particular, mid-semester evaluation (maximum - 60 points), and the final exam – (maximum – 40 points). The minimum level of competence is defined in each form of assessment. Final assessment (minimum – 20 points), midsemester test – (maximum 30 points). Minimum positive assessment is 15 points, maximum point of current activity is 30, minimum positive assessment - 15 points.

The forms of assessment:

- Intermediate assessment
- Final/additional exam

Components of Intermediate assessment:

- Midsemester Exam
- Current Activity:
  - Testing with open or closed questions;
  - Performing practical / theoretical homework;
  - Thematic project;
  - Coursework/project;
  - Written and / or oral inquiry;
  - Laboratory activity;
  - Seminar activity;
  - Participation in the discussion;

One mid-semester exam is held per semester. It is a necessary component of interim assessment.

Evaluation Methods:
- Testing with open questions;
- Written examination;
- Description / conducting of laboratory work;
- Description / conducting of practical work;
- Examination with open questions;
- Ability to complete and defend the project.

The Syllabi provide relevant forms and methods of assessing the student's knowledge, description of corresponding forms and methods of evaluation, criteria and scales.

Assessment of scientifical-research component/components

a) Perfect (*summa cum laude*) – excellent work;
b) Very good (*magna cum laude*) – result which is more than required;
c) Good (*cum laude*) – result which fully complies with the requiremets;
d) Fair (bene) – result which fully complies with the requiremets inspite of some flaws;
e) Satisfactory (*rite*) – result which complies with the requirements inspite of some flaws;
f) Insufficient (*insufficienter*) – result whict does not complies with the requirement because of significant flaws;
g) totally unsatisfactory (*sub omni canone*) – result which does not compies with any requirements.

Sphere of Employment

The graduates of the doctoral program of Biomedical Engineering can find jobs on the labor market, as well as in the international area, in the hospital sector, as clinical and medical informatics engineers, qualified experts of medical techniques and technologies, in governmental or nongovernmental organizations, in foreign firms and their agencies producing medical equipment and technologies, in insurance companies, in service and processing companies of information-communication systems of healthcare.

They will also have the competence of occupying academic positions at higher education institutions and conduct teaching of biomedical engineering, medical informatics, equipment-making and computer science engineering programs at all three levels of higher education.

Doctors in Biomedical Engineering will serve the public in the field of medicine to solve complex problems connected with advanced engineering and healthcare information technologies, to ensure international standards of healthcare and high quality health services.

Human and Material Resources Required to Implement the Program

The ability to achieve the goals and learning outcomes of the Doctoral Program is provided by equiped educational class-rooms, labs, libraries and library fund (books and electronic resources), computer classes, software programs, and ceaseless internet, ISO standard accredited "Laboratory of the Quality Control of Medical Equipment - Medical Equipment Inspection Authority".

The representatives of the "Committee Supporting the Development of BME studies in Georgia" which has been founded at the "Association of Biomedical and Clinical Engineering Society of Georgia", also the academic staff of West Pomeranian University (Poland) participated in the preparation of the program. On the basis of the agreement between Georgian Technical University and West Pomeranian Technological University, the students admitted to the program will be able to work on a part of research component of the PH.D program at Szczecin West Pomeranian University.

On the basis of similar agreement, for internationalization purposes, the students admitted to the program will be able to work on research component at Patras University (Greece). There is also good practice of implementing doctoral works in biomedical engineering and medical physics at Julich Research Center of the Federal Republic of Germany - Forschungszentrum Jülich (JÜLICH) in nuclear physics, neuro-medicine and medical and electrical engineering institutions.

The programme will be fulfilled by the following personel (CV-s are attached to the programme):

1. Professor Irine Gotsiridze –Ph.D Biological Science
2. Professor Zviad Gurtskaia- Ph.D Technical Sciences, Doctor of Medicine
3. Professor Rusudan Gotsiridze – Ph.D Pedagogocal Sciences
4. Professor Paata Kervalishvili-Doctor of Physical and Mathematical Sciences
5. Professor Irine Khomeriki- Doctor of Technical Sciences
6. Invited professor David Nadareishvili

Professors from West Pomeranian University Of Technology:

1. Professor Krzysztof Okarma
2. Professor Krzysztof Penkala
3. Associated Professor Woichech Chlewicki

Professor of Patras University:

1. Professor Konstantinos Moustakas

Agreement about the joint supervision of PH.D. students (Cotutelle agreement) may contain specific regulations which will be specified and thoroughly discussed in the agreement.

The Number of Syllabi Attached: 10

Courses in the Program

№	Learning and Research Components	Admission prerequisites	ECTS Credits					
			Year I		Year II		Year III	
			Semester					
			I	II	III	IV	V	VI
1	Scientific Communication Techniques	No prerequisites	4					
2	Research Methods in Biomedical engineering	No prerequisites		5				
3	Teaching Methods and Education Management	No prerequisites	6					
	Special Mandatory Courses							

4	Biomedical Sensors And Measurement Transducers	No prerequisites	5					
5	Radiation Safety And Dosimetry	No prerequisites	5					
6	Control Systems In Biomedicine	No prerequisites		5				
	Elective Courses	No prerequisites		5				
7	Physiology and Electrophysiology For Engineers	No prerequisites		5				
8	Medical Image Analysis	Biomedical Sensors And Measurement Transducers						
9	Artificial Organs	Biomedical Sensors And Measurement Transducers						
10	Clinical Engineering	Radiation Safety And Dosimetry, Research Methods in Biomedical engineering						
11	Thematic Seminar 1	No prerequisites	10					
12	Thematic Seminar 2	Thematic Seminar 1		15				
Research components								
	Colloquium -1	Thematic Seminars Learning Components			30			
	Colloquium -2	Colloquium -1				30		
	Completion and Defense of Dissertation	Learning and Research Components					60	
		Per Year:	**60**		**60**		**60**	
		Total:	**180**					

Learning Outcomes Map

№	Learning and Research Components	Knowledge and understanding	Applying knowledge	Making judgments	Communication skills	Learning skills	Values
1	Scientific Communication Techniques	X	X		X	X	
2	Research Methods in Biomedical engineering	X	X	X	X	X	X
3	Teaching Methods and Education Management	X	X	X	X		X
4	Biomedical Sensors And Measurement Transducers	X	X	X			
5	Radiation Safety And Dosimetry	X	X		X		X
6	Control Systems In Medicine	X	X	X			
7	Physiology and Electrophysiology For Engineers	X	X	X		X	X
8	Medical Image Analysis	X	X	X			
9	Artificial Organs	X	X	X			
10	Clinical Engineering	X	X	X	X	X	X

11	Thematic seminar-1	X	X	X	X	X	X
12	Thematic seminar-1	X	X	X	X	X	X
	Research Component						
13	Colloquium -1	X	X	X	X	X	X
14	Colloquium -2	X	X	X	X	X	X
15	Completion and Defense of Dissertation	X	X	X	X	X	X

Program Curriculum

№	Course code	Learning component	ECTS Credit/Hours	Hours							
				Lecture	Seminar (work in the group)	Practical classes	Laboratory	Practice	Mid-semester exam	Final exam	Independent work
1	LEH16508E1-LS	Scientific Communication Techniques Study	4/100	15	15	-	-		1	2	67
2	EET06108E1-LS	Research Methods in Biomedical engineering	5/125	15	30	-			1	2	77
3	EDU11012E1-LP	Teaching Methods and Educational Management	6/150	15	-	45			1	2	77
4	EET06208E1-LP	Biomedical Sensors And Measurement Transducers	5/125	15		30	-		1	2	77
5	PHS68208E1-LP	Radiation Safety And Dosimetry	5/125	15	-	30	-		1	2	77
6	EET06208E1-LP	Control Systems In Biomedicine	5/125	15	-	-	30		1	2	77
7	BRS16608E1-LB	Physiology and Electrophysiology For Engineers	5/125	15	-	-	30		1	2	77
8	EET06408E1-LP	Medical Image Analysis	5/125	15	-	30			1	2	77
9	EET32008E2-LS	Artificial Organs	5/125	15	30	-			1	2	77
10	EET32108E2-LR	Clinical Engineering	5/125	15	-	-		100	1	2	7
11	-	Thematic Seminar-1	10/250			-			1	2	247
12	-	Thematic Seminar-2	15/375						1	2	372
13	-	Colloquium -1	30/750							2	748
14	-	Colloquium -2	30/750							2	748
15		Completion and Defense of Dissertation	60/1500								1500

Program Supervisor Irine Gotsiridze

Faculty of Informatics and Control Systems
Head of Quality Assurance Service of the Faculty Zurab Baiashvili

Dean of the Faculty Zurab Tsveraidze

Aproved by:
Informatics and Control Systems Faculty
At the meeting of Faculty Council
06. 02. 2017
Chairman of the Faculty Council Zurab Tsveraidze

Agreed with:
Quality Assurance Service of GTU Irma Inashvili

Modified by:
Informatics and Control Systems Faculty
At the meeting of Faculty Council
25. 06. 2018
Chairman of the Faculty Council Zurab Tsveraidze