Coordinated with the Quality Assurance Office
Minutes № 8, 21 September, 2020year
Head of the office /Associate Professor Nino Jojua/
Reviewed at the Faculty Board
Minutes №28, 28 September, 2020 year
Dean of the Faculty / Professor Tea Kbiltsetskhlashvili /
Approved by the Academic Board
Minutes №7, 29 September, 2020 year
Rector / Saffet Bayraktutan /

Doctorate Educational Program

Computer Science (English)

Tbilisi
2020 year

IBSU

EDUCATIONAL PROGRAM

Name of the Educational Programme: Computer Science / კომპიუტერული მეცნიერება

Faculty: Business and Technology

Programme Coordinator(s): Affiliated Prof. Dr. Irakli Rodonaia, Phone: +995 599 243982, Email: irakli.rodonaia@ibsu.edu.ge;

Programme Co-Coordinator(s): Dr. Besik Dundua, Phone: +995 591818287, Email: bdundua@ibsu.edu.ge,
Dr. Marina Razmadze, Phone: +995 593 636233, Email: mrazmadze@ibsu.edu.ge

Education Cycle and Level of the qualification: Doctorate (The third cycle of Higher Education) Level 8 of the NQF

Type of the Educational Programme: Academic / Major

Detailed Field and Code (ISCED – F – 2013): Information and Communication Technologies 06, Computer Sciences 0613

Awarded Qualification: Doctor of Computer Science/კომპიუტერული მეცნიერების დოქტორი

Code of Qualification: 0613

Language of Education: English

Credit Value of the Programme: 60 credit ECTS (study components)

Structure of the Programme: The University uses the European Credit Transfer System (ECTS): 1 credit = 25 hours, which covers both, contact and student independent working hours. The duration of the educational program is not less than 3 years, program includes 60 credits of study components and research components (dissertation).

The program includes: Mandatory courses 30 credits and elective courses 30 credits (10 courses are offered as elective courses, each has 10 credits – totally 100 credits);

Program Admission Precondition: According to Georgian legislation, the candidate to enroll at this program should have a Master's degree in computer science or closely related fields. According to the university regulations, the candidate should have at least the B2 level in English certified by an international certificate and the relevance is approved by the IBSU School of Languages or a Master's diploma received from English touch program during last five years. In addition, according to the university regulations, the candidate has to submit a dissertation (research) proposal. The correspondence of the proposal to the program requirements is assessed by the Dissertation Field Board commission based on the following assessment criteria:

	Unacceptable	Acceptable, with major changes	Acceptable, with minor changes	Acceptable
Problem formulation, novelty, significance of the research topic: Stating the research problem clearly, providing motivation for undertaking the research	0-4	5-8	9-12	13-16

Literature overview: Demonstrating knowledge of prior work on the specific research topic	0-4	5-8	9-12	13-16
Theoretical and practical value: Demonstrating how the solution of the research problem can impact the field	0-4	5-8	9-12	13-16
Methodology: Describing an adequate methodology to study and solve the research problem	0-4	5-8	9-12	13-16
Results: Analyzing and interpreting research results/data effectively	0-4	5-8	9-12	13-16
Communication: Quality of both Writing and Oral Communication.	0-5	6-10	11-15	16-20

Total:	100

A candidate should collect at least 51 points to be eligible to study at the PhD program. In the case of competition, candidates with higher points will be admitted.

Purpose of the Programme:

The goals of the PhD Program in Computer Science are:

1. Preparation of highly qualified personnel for academic and scientific careers in the field of computer science. The faculty has three directions of computer science: theoretical computer science, system design and security, artificial intelligence. The doctoral program is designed to take into account the interests of individual students, which means that students must make a distinct and important contribution to the study and development of at least one direction while studying for a doctorate.
2. To prepare computer science PhD students for industry, which means that PhD students will develop the ability to formulate, model, analyze, solve and implement complex problems coming from the industry.
3. To develop PhD students the skills necessary for a successful career in the market, to make it focused on finding ways to solve interdisciplinary scientific problems, to improve the vision of professional and ethical responsibility for academic, scientific and industrial work.

Learning Outcome: After completing the PhD Program of Computer Science, the graduate will have the following competencies necessary for his / her specialization.

Knowledge and understanding	1. Graduates demonstrate a systematic understanding of the field of computer science. 2. Graduates have a deep understanding in the three major areas of computer science: theoretical computer science, systems design and security, artificial intelligence. 3. Graduates have a knowledge to evaluate critically a solution to a complex research level problem, and propose possible improvements. 4. Graduates know how to prepare project proposals, how to write obtained scientific results and make presentation. 5. Graduates know how to use computer systems, how to develop software, and how to model real-world problems.
Ability	6. Graduates are able to carry out scientific research, review scientific papers and dissertations, and publish an article describing scientific results in a highly ranked refereed journal and conference materials. 7. Graduates can occupy academic positions at the university, deliver lectures in various fields of computer science, and supervise undergraduate, graduate, and doctoral studies.
Responsibility and autonomy	8. Graduates are aware of the potential ethical and social implications of research, peer review, technology development, and application. 9. Graduates are professionals in the field of computer science, they are aware of the achievements in the field and consider their work as an integral part of this field.

Program goals and learning outcomes map:

Program goals	learning outcome 1	learning outcome 2	learning outcome 3	learning outcome 4	learning outcome 5	learning outcome 6	learning outcome 7	learning outcome 8	learning outcome 9

(1)	✔	✔	✔	✔	✔	✔	✔		
(2)	✔	✔	✔	✔	✔	✔	✔		
(3)								✔	✔

Learning Outcome Map:

Course / Module / Internship / Research Component	Criteria of Competencies								
	Knowledge and Understanding					Skills		Responsibility and autonomy	
	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
Pedagogy of Higher Education							3		
Research Methodology	2	2	2	3		3	1	3	2
PhD Seminar I	2	2	1	2	1	2	1	2	2
PhD Seminar II	2	2	1	2	1	2	1	2	2
Professor's Assistantship	2	2	2	2	2	2	3	2	2

PhD Thesis	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Cyber Physical Systems	**1**	**3**	**2**		**2**				
Wavelets Theory	**1**	**2**	**2**		**1**				
Computational Thinking for Modeling and Simulation	**1**	**1**	**2**		**3**				
Automated Reasoning	**1**	**3**	**2**		**1**				
Internet of Things (IoT)	**1**	**3**	**2**		**1**				
Access Control Models	**1**	**3**	**2**		**2**				
Blockchain and Cybersecurity	**1**	**3**	**2**		**1**				
Discrete Optimization Algorithms	**1**	**3**	**2**		**1**				
Rewriting Theory	**1**	**3**	**2**		**1**				
Pattern Recognition Applications	**1**	**3**	**2**		**2**				

Methods of Attainment of Learning Outcomes: Study components considered by the program are carried out using following teaching and learning methods:

Lecture – Lectures involve discussion of major theoretical material, concepts, terms, etc. through ensuring students' active involvement. It is basically oriented on thorough teaching scientific theories and approaches of study material. During lectures,

subject related issues are deeply explained, students are actively involved in the discussions and clear perception and comprehension of topics using brain-storming and other interactive methods.

Group work – Group work develops the knowledge and skills of planning and fulfillment of specific tasks under cooperative environment. Group work includes discussion of case studies, quizzes, practical assignments, different examples, through which students obtain skills of problem resolution in teams that in turn ensures development of team working skills and the possession of competencies of considering and accepting others opinion.

Practice / lab work – In order to ensure deep understanding and perception of the issues, practice/lab work concentrates on accurate discussion of relevant examples, cases, video materials, exercises and the ways of their resolution, which ensures the formation of students' ability to use the obtained theoretical knowledge in practice and develop analytic and creative thinking.

Seminar – The aim of seminars is to create the context for students which enables them to get the details, and better understand and realize the issues and topics discussed during lectures. Seminar is the means of knowledge transfer, involves discussion and drawing conclusions, and it is coordinated by a lecturer with certain specific objectives. Seminars are conducted in accordance to specific aims and are in line with the material covered throughout lecturers.

Individual work – Through individual work students deepen and internalize the knowledge obtained throughout the lecturers. Individual work involves searching for the materials through course-books or other sources of information, realizing and learning the obtained information; it also involves completing home-tasks. All these activities deepen the interest in certain issues, the wish to study these issues individually, they help students develop the ability of thinking individually, analyze the obtained information and draw conclusions.

Specificities of the Organization of the Teaching Process: The learning and teaching methods are implemented using the following activities:

Presentation (by lecturer) – The method consists of narration and speaking through which the information is provided by a teacher to a learner. Through this process teacher transfers knowledge verbally, explains the material and students obtain this knowledge through listening, memorizing and comprehension. It is important to make sure that understanding occurs and information is

perceived correctly. In case of necessity additional instruction should be provided. A teacher is giving specific examples and provides detailed explanation.

Demonstration - It demonstrates information visually. It's sufficiently effective when reaching the result because it takes into consideration the interests of different students. Learning material can be demonstrated by lecturer or student. This method helps different steps of learning process to be seen visually and concretize, what should student do independently. At the same time, this strategy visually demonstrates the main point of the subject/problem.

Induction – modern, one of the most effective student-oriented methods. Major objective of this method is to collect much data and by generalizing the observed perspectives discover general principles through which it is possible to discuss the facts, cases and events and explain them. Learning is oriented at relying on facts and developing rules through generalizing these facts, thus, moving from specific facts to general rules.

Deduction – a traditional method of teaching and learning which sees a teacher as a major source of information and students learn general theories through a teacher's supervision. Deductive method of learning determines that kind of any subject knowledge, which presents the process when depending on general knowledge we discover new knowledge, so the process goes from general to concrete.

Analysis – In the modern world majority of disciplines have become complex; accordingly, courses in these fields require complex approaches. The method of analysis helps us to dismantle multi-disciplinary and inter-disciplinary courses into parts which allows dividing an issue under the study into separate aspects. This helps to discuss separate issues in details.

Synthesis - Method of synthesis means back-procedure, using some parts and making the whole with them. This method helps to see the whole problem.

Case Study – active problem-situation analysis method, which presupposes discussing real cases and discussing them which allows students to look at the issues from different perspectives, analyze possible solutions of the problem and choose and justify specific strategies, objectives and expected outcomes. A case presents a context and it is an instrument by itself which allows a student to use specific knowledge obtained through the course and put it into practice in the context which is close to real-life situation.

Brain Storming - collecting as many/various ideas about the topic/issue as possible. The method enhances development of creative approach towards the problem. It supports the development of creative approaches when students try to see an issue from different perspectives. This approach ensures that every person is involved in the learning process. It is efficient for a large group and is used in stages.

Discussion / Debates – one of the most broadly spread interactive methods; discussion raises the level of student involvement; while discussion different opinions are confronted and the discussion is not limited to the questions asked by a teacher. Overall aim is to synthesis different views. This method develops students' ability of reflection and argumentation.

Simulation, Role Plays and Situational Games – belong to game-type of methods which consist of simulation (role-play) games, didactic or educational games, situational games, game-like approaches and procedures. Games developed through pre-developed scenarios enable students to look at important issues from different perspectives. They help students to form alternative viewpoints. Like discussion, these games develop students' ability to express their own opinion independently and defend their attitudes in a dispute.

Project – This approach is a unity of perceptive methods, which makes it possible to solve a problem through students' independent work and presenting the achieved solutions. This approach raises students' motivation and responsibility; working on the project involves planning, research, practical activities and presenting the results; the projects are complete if the outcomes are presented in a convincable manner through examplifying specific results; a project could be done individually, in peer or group work; upon completion, the project is presented to a broader audience.

Presentation (by student/students) – Taking into consideration the development of technology presentation is one of the most interactive and effective ways of teaching. It is a combination of teaching and learning methods which allows a student to solve a problem through independent work and presenting the outcomes. This method raises students' motivation to work independently; it also develops specific skills – planning, researching, and presenting data in an effective manner; it develops skills to work in groups or individually.

Teaching though Electronic Sources – The method implies teaching through internet and the means of multimedia. It consists of all the components of teaching process that are realized through specific means of internet and multimedia.

Task Solving – Gradual mastering of theoretical material through solution of specific tasks that ensures development of skills of using theoretical knowledge independently. While solving the tasks the lecturer pays attention to the methods of task solution and to the relevant use of the various schemes or chart drawing techniques or to the techniques of task solution;

Problem Solving – The method of teaching that enables employment of newly obtained knowledge by students through study, analysis and solution of specific problem. While employing this method it is important to assess and analyze the results received through the solution of a specific problem. By using this method the skills and the ability of a student to use obtained knowledge in practice is developed.

Group Work – Teaching method through which students are divided into the groups and the assignments are given to each of the groups. Group members process the information individually and share their ideas to other group members at the same time. Group members may be assigned different functions depending on the objective defined by the task. This method ensures active involvement of each student in the process of teaching.

Individual Work – The method when a student individually performs the tasks and the assignments determined through the academic process.

Working with a Course-Book – Actively used method in a process of learning through which a student process given material by using given literature and other sources.

Doing Homework – Independent work when students do the home assignments determined through the academic process. Doing home assignments implies reading, processing and studying material determined through the study course as well as doing given assignments in written form or presenting them orally.

Student Knowledge Evaluation System:

The goal of evaluation is to determine student's education results qualitatively in relation to academic program goals and parameters.

Student may be assessed orally and/or in a written way. A student's knowledge and skills are assessed through 100 points grading system. It consists of midterm and final evaluations, sum of which makes up 100 points.

Grading system allows:

a) five types of positive grades:
   1) (A) Excellent – 91-100 points of assessment;
   2) (B) Very good – 81-90 points of maximal assessment;
   3) (C) Good - 71-80 points of maximal assessment;
   4) (D) Satisfactory - 61-70 points of maximal assessment;
   5) (E) Enough - 51-60 points of maximal assessment;
b) two types of negative grades:
   1) (FX) Fail – 41-50 points of maximal assessment, meaning that a student requires some more work before passing and is given a chance to sit an additional examination after independent work;
   2) (F) Fail – 40 points and less of maximal assessment, meaning that the work of a student isn't acceptable and he/she has to study the subject anew.

For the midterm and final evaluations minimal passing grade is set. The final evaluation minimal passing grade must not exceed 60% of final evaluation grade.

Midterm and final evaluation grade distribution, their minimal competence levels and assessment criteria are described in the corresponding syllabus (40% for midterm and 50% for final).

A credit can be awarded only after the attainment of learning outcomes, envisaged by the course syllabus and following requirements (both have to be fulfilled):

a) Obtaining minimal competence levels set for midterm and final evaluations;

b) Obtaining minimum 51 points out of 100 points of final grade.

A student is allowed to take an additional (make-up) exam in case he/she scored 41-50 points of final grade or minimum 51 points, but did not obtain minimal competence level set for final evaluation.

Organization of educational and research process:

The PhD program is normally continues not less than three years and combines study and research components. During first year, students are expected to complete study component, which means they have to collect 60 ECTS credits from courses offered by the curriculum. According to curriculum students are supposed to collect 30 ECTS from mandatory courses and 30 ECTS from elective courses. Elective courses are distributed as follows:

- Theoretical computer science courses: discrete optimization algorithms, rewriting theory, automated reasoning;
- System design and security courses: cyber physical systems, access control models, blockchain and cybersecurity.
- Artificial intelligence courses: computational thinking for modeling and simulation, internet of things (IoT), wavelets theory, pattern recognition applications.

After completion of the study component, students will have to work on their PhD research.

To be admitted to the PhD defense the following requirements should be fulfilled:

1. Students should publish (accepted for publication) at least one paper dealing with dissertation results in a journal indexed by Clarivate Analytics databases or in a conference proceeding indexed by CORE.
2. The PhD thesis should be reviewed by two international field experts (researchers with a doctoral degree who works in a foreign educational or scientific organization) and both reviews has to be positive.

If both requirements are fulfilled, thesis defense is scheduled and Dissertation Board Commission which involves supervisor and both reviewers evaluates the thesis by a maximum of 100 points with the following criteria:

Criteria	Maximum grade of evaluation
Problem formulation	15 points
Literature review	15 points

Novelty and importance of obtained results	40 points
Thesis structure and formatting	15 points
Thesis presenatation and answers to questions	15 points
Total	**100 points**

The assessment of dissertation fiinally is done with the following wording:

a) Excellent (summa cum laude) – 91points and over of maximum point – an excellent performance;

b) Very good (magna cum laude) – 81-90 points of maximum point – a result exceeding given requirements in all aspects;

c) Good (cum laude) – 71-80% of maximum point – a result exceeding given requirements;

d) Average (bene) – 61-70 points of maximum point – a result satisfying given requirements in all aspects;

e) Satisfactory (rite) – 51-60 points of maximum point – a result satisfying given requirements despite some mistakes;

f) Unsatisfactory (insufficienter) – 41-50 points of maximum point – a result not satisfying given requirements because of serious mistakes;

g) Absolutely unsatisfactory (sub omni canone) – 40 points and less of maximum point – a result absolutely not satisfying given requirements.

The student is awarded the academic degree of doctor in case of obtaining any of the above mentioned grades considered by items from a) to e); in case of getting the grade considered by item f) – the student has a right to present the rewritten doctorate dissertation during the first year; and in case of getting the grade considered by item g) – the student has no right to present the same doctorate dissertation.

Field of Employment:

The PhD program in Computer Science will prepare internationally qualified competitive professionals. The knowledge and skills acquired by graduates will enable them to meet the challenges of modern scientific achievements. Graduates will be able to be employed in both private and public sectors, as a leading specialist, where they will practically perform the main professional activities both independently and in a group. In particular, they can occupy a scientist position at research unit, an academic position at educational organization and a leading specialist position at IT department in an industry.

Information Concerning Material Resources Necessary for the Implementation of the programme:

Information Concerning Material Resources Necessary for the Implementation of the programme: International Black Sea University is fully equipped with all the necessary material resources aimed to fulfil the educational program successfully:

- Classrooms equipped with different educational facilities;
- Computer laboratories with full internet access;
- University library equipped with modern technologies, internet, and rich paper and electronic books;
- Corresponding resources to the course relevant topics available through the electronic database of the university (through Smart portal);
- Other material resources owned by the university.

- Compulsory literature indicated in syllabuses is available in the university's library. Also via an electronic library; IBSU is a registered member of the following e-libraries. IBSU is officially involved in the ELSEVIER international scientific system. IBSU staff and students are able to have an access to the Elsevier databases such as Scopus; Science Direct; Scival Funding (Funding Institutional)

  https://www.ebsco.com/
  https://www.elsevier
  http://polpred.com/
  www.journals.cambridge.org
  https://home.heinonline.org/
  www.opendoar.org
  www.roar.eprints.org
  www.doaj.org
  www.beallslist.weebly.com
  www.gutenberg.org
  www.memory.loc.gov
  www.wdl.org
  www.obiblio.sourceforge.net

- In addition, the university has all the means for extracurricular activities for students (sports, creativity, social activities);

Information Concerning Human Resources Necessary for the Implementation of the programme:

№	Name, Last name	Academic degree	Position
1.	Michał Małafiejski	Doctor of Computer Science (Habilitation)	Affiliated Professor
2.	Vakhtang Kokilashvili	Doctor of physics and mathematics Sciences (Habilitation)	Affiliated Professor

3.	Irakli Rodonaia	PhD (Doctor of Philosophy) in Technology, Candidate of Technical Sciences	Affiliated Professor
4.	Mikheil Rukhaia	Dr.Techn area of concentration Computer Science (Equivalent to PhD)	Associate Professor
5.	Natela Doghonadze	Doctor of Science degree in Methods of Teaching	Affiliated Professor
6.	Vakhtang Rodonaia	PhD degree in Engineering of Informatics (Equivalent to PhD)	Affiliated Associate Professor
7.	Besik Dundua	Doctor of Computer Science	Professor
8.	Khatuna Chargazia	Candidate of physics and mathematics Sciences (Equivalent to PhD)	Affiliated Associate Professor
9.	Giorgi Ghlonti	Candidate of Technical Sciences (Equivalent to PhD)	Affiliated Associate Professor
10.	Mariam Dedabrishvili	Doctor of Engineering in Informatics (Equivalent to PhD)	Affiliated Assistant Professor

IBSU

EDUCATIONAL PROGRAM

Study Plan

#	Course / Module / Internship / Research Component	Status	Credit number	Distribution of credits per courses and semesters								Distribution of hours							Number of contact hours per week
				I s.y.		II s.y.		III s.y.		IV s.y.		Contact hours					Independent work	Total number of hours	
				I Semester	II Semester	III Semester	IV Semester	V Semester	VI Semester	VII Semester	VIII Semester	Lecture / Consultation	Seminar / Group Work / Laboratory Work / Practical work	Midterm exam(s)	Final exam	Total number of contact hours			
1	Pedagogy of Higher Education	Mandatory	5	5								8	20	2	2	32	93	125	2
2	Research Methodology	Mandatory	10	10								15	13	2	2	32	218	250	3

3	PhD Seminar I	Mandatory	5	5								0	15	0	0	15	110	125	2
4	PhD Seminar II	Mandatory	5		5							0	15	0	0	15	110	125	2
5	Professor's Assistantship	Mandatory	5		5							30	0	0	2	32	93	125	2
6	PhD Thesis	Mandatory										120				120	2880	3000	2
7	Cyber Physical Systems	Elective	10	10								28	15	2	2	47	203	250	3
8	Wavelets Theory	Elective	10	10								29	14	2	2	47	203	250	3
9	Computational Thinking for Modeling and Simulation	Elective	10	10								14	29	2	2	47	203	250	3
10	Automated Reasoning	Elective	10	10								28	15	2	2	47	203	250	3
11	Internet of Things (IoT)	Elective	10	10								29	14	2	2	47	203	250	3
12	Access Control Models	Elective	10		10							28	15	2	2	47	203	250	3
13	Blockchain and Cybersecurity	Elective	10		10							28	15	2	2	47	203	250	3
14	Discrete Optimization Algorithms	Elective	10		10							34	9	2	2	47	203	250	3
15	Rewriting Theory	Elective	10		10							29	14	2	2	47	203	250	3
16	Pattern Recognition Applications	Elective	10		10							29	14	2	2	47	203	250	3

IBSU

EDUCATIONAL PROGRAM

Total number		**60**	**30**	**30**							**257**	**108**	**10**	**12**	**387**	**4113**	**4500**	**22**

Table of Requirements

#	Course title	ECTS	Prerequisite	Semester course
4	PhD Seminar II	5	PhD Seminar I	2
5	Professor's Assistantship	5	Pedagogy of Higher Education	2
6	PhD Thesis		All mandatory courses	3,4,5,6

* - List all those courses which are necessary for a student to pass in order to take a particular course/block/module

Additional Table of Study Plan

№	Course / Module / Internship / Research Component	Code	Semester	Prerequisites	Lecturer	Obligatory Literature
1	Pedagogy of Higher Education	CS401	1	N/A	Natela Doghonadze	1. Eggen, P. and Kauchak, D. (2004). Educational Psychology. Pearson Education 2. Ambrose, S.A. et al. (2010). How learning works. San Francisco: Jossey-Bass.

						3.Doghonadze, N. (2015). Higher Education Pedagogy. Course notes. Tbilisi. IBSU – available at SMART Learning.
2	Research Methodology	CS402	1	N/A	Giorgi Ghlonti	1.Gordana Dodig-Crnkovic. Scientific Methods in Computer Science, Proc. Conf. for the Promotion of Research in IT at New Universities and at University Colleges in Sweden, Skövde 2002, http://www.mrtc.mdh.se/publications/0446.pdf. 2.Gallier, J.H.: Logic for Computer Science: Foundations of Automatic Theorem Proving. Wiley, 1987. 3.Elio, R., Hoover, J., Nikolaidis, I., Salavatipour, M., Stewart, L., and Wong, K. About computing science research methodology. 2011. 4.L. Synder. "What is Experimental Computer Science?". School of Computing and Mathematics, Deakin University. Technical Report TR C95/18. March, 1998 5.Richard Hammack, Book of proof, VCU, 2009. 6.Johnson, B. and Christensen, L., Educational Research – Quantitative and Qualitative Approaches. Boston: Allyn and Bacon (2000). 7.Gilbert, Nigel and Troitzsch, Klaus G. Simulation as a Method In: Simulation for the Social Scientist. Open University Press. 2005 8.Pidd, M. Complementarity in systems modelling. In: Pidd, M. (ed.) Systems modelling. Theory and practice. Chichester: Wiley. 2004 9.Nicholas J. Higham. Handbook of Writing for the Mathematical Sciences. Society for Industrial and Applied Mathematics, Philadelphia, PA, 2nd edition, 1998.

						10.T. Oetiker, H. Partl, I. Hyna, and E. Schlegl. The Not So Short Introduction to LaTex 2ε, June 2014. 11.J. Singer and N. G. Vinson. Ethical issues in empirical studies of software engineering. IEEE Trans. Software Eng., 28(12):1171–1180, 2002
3	PhD Seminar I	CS403	1	N/A	All academic staff	Any material selected from the internet or library, which is relevant to the research topics selected by the students.
4	PhD Seminar II	CS404	2	PhD Seminar I	All academic staff	Any material selected from the internet or library, which is relevant to the research topics selected by the students
5	Professor's Assistantship	CS405	2	Pedagogy of Higher Education	All academic staff	Will be given to the student by the professor, according to the class / activity delivered
6	PhD Thesis	CS406	3,4,5,6	All mandatory courses	All academic staff	More than 100 references (research articles, books, dissertations) related to the doctorate student's research topic. The majority of them have to be quite recent. Electronic reources, except respectable organizations like UNESCO, ministries of education, etc. should be avoided.

7	Cyber Physical Systems	CS407	1	N/A	Vakhtang Rodonaia	William Stallings. Network security essentials: applications and standards. Fourth edition. Prentice Hall. Pearson. 2011
8	Wavelets Theory	CS408	1	N/A	Vakhtang Kokilshvili	1.Martin Vetterli and Jelena Kovacevic, Wavelets and Subband Coding. Prentice Hall, New Jersey, 1995. 2.Stephane Mallat, A Wavelet Tour of Signal Processing. Academic Press, 2001
9	Computational Thinking for Modeling and Simulation	CS409	1	N/A	Khatuna Chargazia	Guttag, John. Introduction to Computation and Programming Using Python: With Application to Understanding Data. 2nd ed. MIT Press, 2016. ISBN: 9780262529624.
10	Automated Reasoning	CS410	1	N/A	Mikheil Rukhaia	J. Harrison. Handbook of Practical Logic and Automated Reasoning. Cambridge University Press, 2009.
11	Internet of Things (IoT)	CS411	1	N/A	Irakli Rodonaia	1. D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, J. Henry. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things . Cisco Press, ISBN-13: 978-1-58714-456-1, ISBN-10: 1-58714-456-5, 2017 2.Charles Bell. Windows 10 for the Internet of Things. Apress, ISBN-13 (pbk): 978-1-4842-2107-5, ISBN-13 (electronic): 978-1-4842-2108-2, 2016
12			2	N/A		1. Messaoud Benantar. Access Control Systems - Security, Identity Management and Trust Models. Springer, 2006.

	Access Control Models	CS412			Mikheil Rukhaia	2.David Ferraiolo, Richard Kuhn, Ramaswamy Chandramouli; Role-Based Access Control, Second Edition, Artech House, 2007.
13	Blockchain and Cybersecurity	CS413	2	N/A	Mikheil Rukhaia	1. Technology Innovation Management Review, Volume 7, Issue 10, October 2017. 2. Melanie Swan. Blockchain - Blueprint for a New Economy. O'Reilly Media, 2015. 3.Rajneesh Gupta. Hands-On Cybersecurity with Blockchain. Packt Publishing, 2018.
14	Discrete Optimization Algorithms	CS414	2	N/A	Michał Małafiejski	1.Lecture notes & slides 2.Vijay Vazirani, Approximation Algorithms, Springer (2002)
15	Rewriting Theory	CS415	2	N/A	Besik Dundua	M. Bezem, J. W. Klop, and R. de Vrijer (eds.). Term Rewriting Systems. Cambridge University Press, 2003.
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