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Introducing Problem Based Learning in Moldova: Toward Enhancing Students' Competitiveness and Employability
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Bachelor's degree programme in „Software Engeneering" at TUM

Technical University of Moldova

Work Package 4

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Summary

Within this Work Package - WP4 - the sustainability strategy for the implementation of PBL, active teaching and learning centered on student at the Technical University of Moldova is presented. This report details the new bachelor's degree programme based on PBL - Software Engineering, a road map and an action plan that will guide staff and university management in their efforts to fully implement PBL, active student-centered teaching and learning in the study programme and university.

The report begins by presenting the TUM's *vision* of the Bachelor's Degree Programme based on PBL - Software Engineering, in particular, with a general description of the study programme, learning objectives and outcomes, and then a presentation of each semester including its learning objectives and learning outcomes, the transition from one semester to another, a description of the work on the project and the semestrial projects, including learning objectives, outcomes and their developments.

In line with the objectives of the PBLMD project to have a 50/50 structure (project / course) it was proposed to develop the educational plan where each semester has a separate project module of 10 ECTS, another 5 credits are included as design works within the disciplines of the semester.

Each semester has a well-defined theme and a supervisor who coordinates the activities of teachers and students so that:

- The theme of the introductory semester is *Problem-based learning of science, technology and society.*
- The theme of the semester 2 is *Engineering and scientific basis of computation.*
- The theme of the semester 3 is *The basics of applications development.*
- Theme of the semester 4 is *Formal languages and compilers.*
- The theme of the semester 5 is *Networks and security.*
- The theme of the semester 6 is *Internet of things (IoT).*
- The theme of the semester 7 is *Information systems.*
- Semester 8 is dedicated to the bachelor's degree project, which is allocated 15 ECTS.

The professional competencies developed by the study programme are determined by the definition of the Software Engineering specialty in accordance with the ACM standard - Association for Computing Machinery and the IEEE Computer Society (ACM and the IEEE-Computer Society, 2015) and require a mix of skills to solve some categories of problems outlined by key competences on:

- the scientific and engineering fundamentals of information technologies;
- the organizational and informational aspects of the systems;
- applications technologies;
- software development methods and technologies;
- architecture and infrastructure of computing systems.

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1. INTRODUCTION

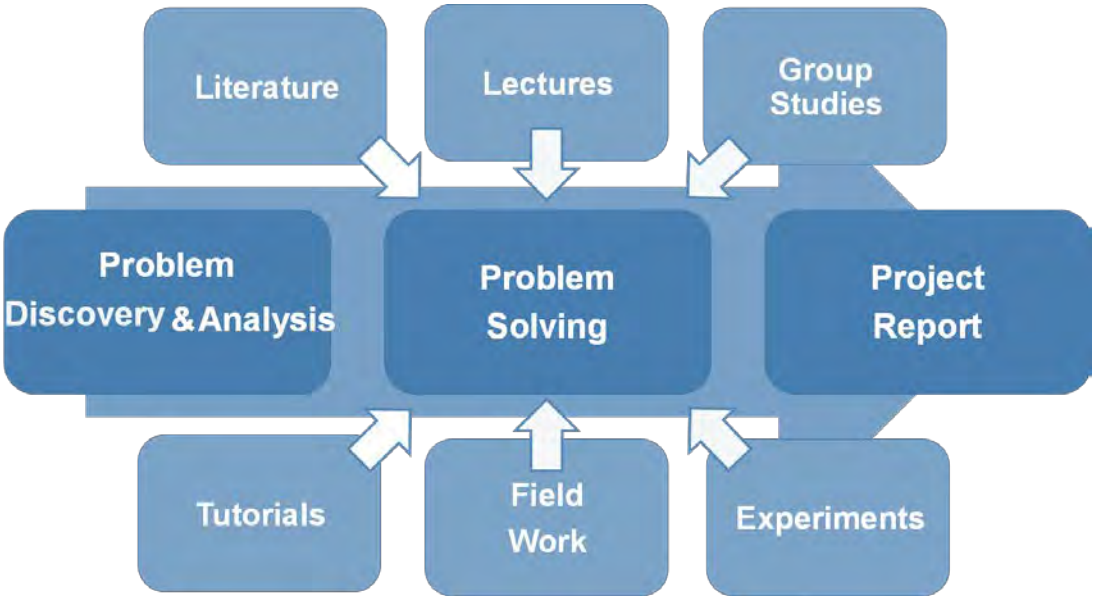
The purpose of this Work Package - PL4 - is to develop a sustainability strategy for the implementation of PBL, active teaching and learning centered on student at the Technical University of Moldova. Specifically, this report will propose an innovative bachelor's degree programme based on PBL Software Engineering, a road map and a detailed action plan that will guide staff and university management in their efforts to fully implement PBL, active student-centered teaching and learning in the study programme and university.

In this report, we rely on WP2 and WP3 that we developed in the period of 2015-2017. We also rely on the experience we have accumulated during our study visits and staff mobility at EU partner universities as well as during the PBL training sessions offered by EU project partners in Chisinau.

1.1 KEY ASSUMPTIONS

There is no PBL model suitable for all purposes. However, PBL-based models are mainly based on two key assumptions. The first assumption is that work on the project is in the *center*, at the basis, consisting of discovery and problem analysis, problem solving and project report (Figure 1). The second assumption assumes that other teaching and learning (face-to-face) activities such as literature, lectures, group studies and tutorials are designed to *support* work on the project. These two assuptions will also be at the base of our PBL, PBL-based bachelor's degree programme in Software Engineering, teaching and student-centered learning, active learning.

Figure 1: PBL Model at AAU: An example

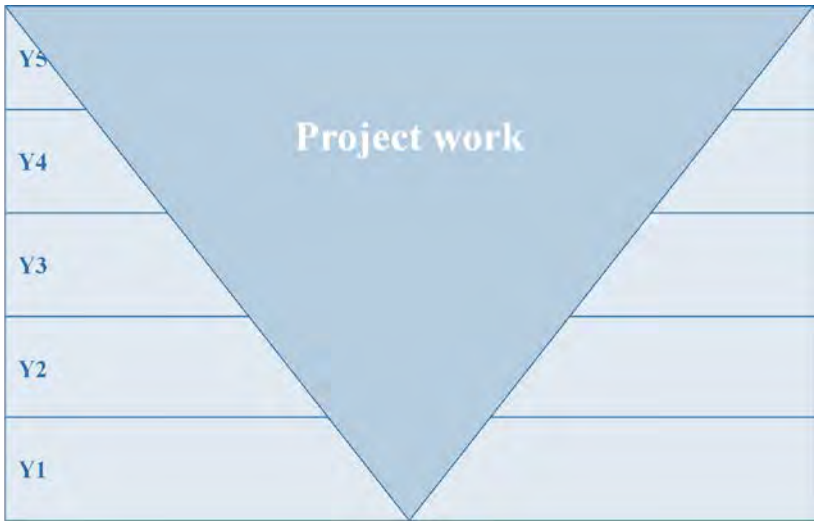


Source: AAU, 2017 (the word 'Discovery' is introduced by Romeo V. Turcan)

Another assuptions relates to the relationship between work on the project and face-to-face activities. In the context of this report, wholly based on PBL, this means a study programme in which there is a 50:50 sharing between student work on the project and face-to-face activities (such as

lectures, seminars, workshops, laboratories and experiments). An example of progression is presented in Figure 2. Of course, there are many ways to distribute the relationship between work on the project and face-to-face activities during the semesters; the main purpose is to achieve an approximate 50:50 time sharing for the duration of the study programme.

Figure 2: An example of 50:50 time sharing between project work and face-to-face activities



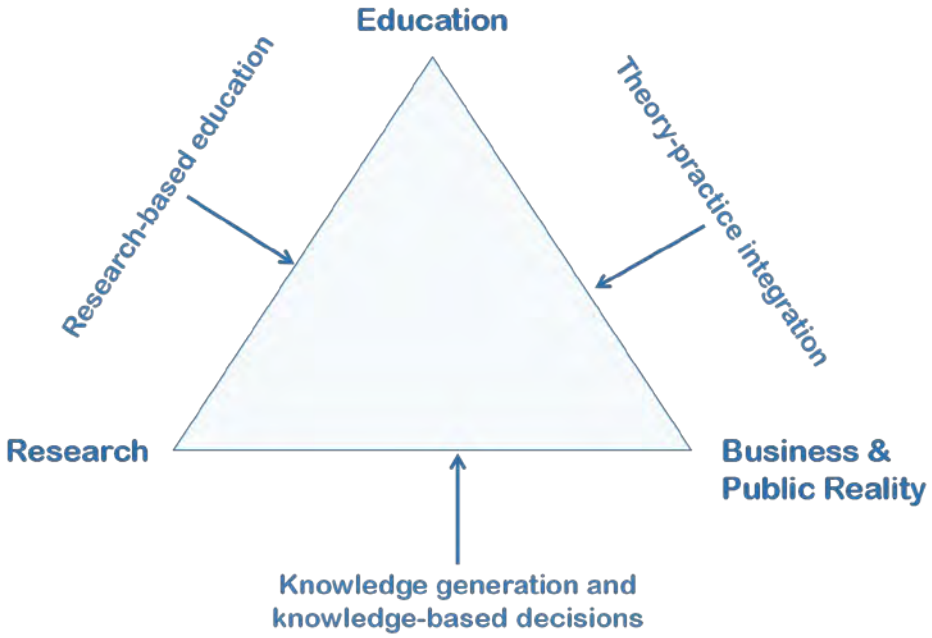
Source: Louise Faber, PBLMD 2016

1.2 EXPECTED OUTCOMES

A number of results are foreseen by the successful implementation of the Bachelor's Degree Programme Software Engineering based on PBL, student-centered and active. It is expected that by 2020, this study programme will become internationally recognized, which will attract European and international students as full-time or exchange students. It is also expected that by 2020 at least five Bachelor's Degree Programmes at our university will be redesigned based on PBs, with active and student-centered teaching and learning methodologies and methods, and that prospective students will be enrolled at these programmes from 1 September 2020. It is also expected to better adapt students' knowledge, skills and abilities to the needs of labor markets.

Successful implementation of the study programme as well as its spread across the university effects will contribute to the further development and consolidation of the integration of education, research and business environment / policy makers' collaboration (Figure 3). Academic staff will excel in engaging in research-based teaching, our students will learn and be able to apply theories in practice, whether in the private or public sector, and our researchers will work with private and public organizations to create and transfer new knowledge.

Figure 3: Socially committed university



Source: Olav J. Sorensen, 2015

1.3 THE PLAN

The report begins by presenting the TUM's *vision* of the Bachelor's Degree Programme Software Engineering based on PBL, in particular, with a general description of the study programme, objectives and learning outcomes, and then a presentation of each semester including its learning objectives and learning outcomes, the transition from one semester to another, a description of the work on the project and the semestrial projects, including learning objectives, outcomes and developments [Annex 1]. Subsequently, the road map [Annex 7] that will guide the process of implementing the Bachelor's Degree Programme Software Engineering based on PBL is presented and detailed. It will be continued by presenting and discussing the action plan that will detail, for example, the specific activities, resources and internal policies needed to successfully implement the visionary study programme. It will conclude by providing university management and university council with a set of policy recommendations on how to improve teaching and learning by introducing PBL, methodologies and active teaching and learning methods centered on student at

2. Our vision of the Bachelor's Degree Programme based on PBL - Software Engineering

In accordance with the objectives of the PBLMD project to have a 50/50 structure (project / course) it was proposed to develop the educational plan in accordance with Annex 1. Therefore, each semester has a separate project module of 10 ECTS, another 5 credits are included as design works within the semesters' disciplines, as observed in the plan (design column). The distribution of the disciplines included in the programme corresponds exactly to the framework plan, and the structure on components is presented in Annex 4.

2.1 OVERVIEW

Software Engineering (IS), along with *Information Technology,* is part of the science of information processing methods and tools *(computing) t*o solve specific problems related to the organization of human activities. In relation to Information Technology, the *Software Engineering* programme is a more theoretical and specialists training-oriented, whose core mission is the development of software production models and techniques, but the scope of which extends to both system infrastructure and organizational and information aspects of companies.

The more theoretical aspect of the field results from the fact that the studied software development processes have a theoretical substrate better grounded in the Software Engineering study programme.

But the programme also includes information application procedures for a specific purpose in the design, construction and use of IT products and services, so there are areas common to the Information Technology programme.

2.1.1 The purpose of the programme

The relevance of the new study programme is also provided by the USAID survey data (O'Sullivan & Bercu, 2016), which highlights the need for more qualified specialists in programme product development.

The high pace of globalization of human society is largely due to information technologies, which provide new opportunities for capitalizing on information. The recognition of this is materialized in various national and international acts:

- The *Europe 2020* Digital Agenda (European Commission, 2010) is one of seven outstanding initiatives under the European Sustainable and Comprehensive Development Strategy and aims to bring major economic and social benefits from a digital single market that already needs to be implemented to ensure: a) 50% of the population to use e-commerce; b) 33% of small and medium enterprises to make online sales; c) 50% of citizens to benefit from e-Government services; d) most public services are accessible online in all EU countries, etc.
- The transformation of the Republic of Moldova into a modern and efficient state is possible only through *technological modernization at the level of society, organizations and*

individuals, actions, also found in the Strategic Technology Modernization Programme of the country (Government Decision, 2011).

*Therefore, **the primary purpose of the study programme** is determined by the need for well-trained engineers in line with the field of professional training, able to offer advanced software solutions and innovations applied to various fields of human activity.*

The Technical University of Moldova, through the Software Engineering and Automatics Department, is *the first university* that since 1993 has trained for the national economy engineers with Bachelor's Degree in Information Technologies. But consultations with partners (public institutions, private companies and students) highlighted the need for new approaches: *teamwork and interdisciplinarity*.

Continuous consultation is manifested through collaborative activities in various workshops and inter-institutional projects involving the members of the department. Private companies that have actively collaborated in consulting or support partnerships include Orange, Starnet, Allied Testing, Endava, Pentalog, JMD Planet, Winify, Evisoft, TenerLab, and Dekart.

2.1.2 Profile of the educational plan

The educational plan for the Bachelor's Degree Programme (Cycle I) - Software Engineering [Annex 2] corresponds to ISCED level 6, being part of:

- Fundamental field of science, culture and technology: *06 Information and communication technologies*
- General field of study: 061 *Information and communication technologies*
- Professional training area: *0613 Development of programme products and applications.*

The plan is approved by the Ministry of Education on 24 July 2017 and published on the website of the University (Technical University of Moldova, Department of Software Engineering and Automatics, 2017).

The study programme is oriented towards training engineers, which would allow the obtaining of the qualification corresponding to level 6 of the National Qualifications Framework / European Qualifications Framework (NQF / EQF). The key features of the professional training programme are presented in Table 2.1 and correspond to the 6th level of the National Qualifications Framework (National Qualifications Framework: Higher Education, 2013).

Table 2.1 - Essential characteristics corresponding to the level 6 of NQF

Level	**Bachelor's degree (Cycle 1) - EQF / NQF level 6**
Length of studies	4 years
ECTS study credits	240 credits
Form of organization	full-time / part-time education
Access conditions	Baccalaureate diploma, secondary school diploma, higher education diploma
Preconditions	Achieving the pre-university learning outcomes
Internships	Compulsory (35 ECTS)
Examination and assessment rules	Current-formative; final-summative assessments are mandatory;

	The current-formative assessment is done through seminars, internships, self-evaluation and assessment of individual work and / or teams; The methodology of final-summative assessment is geared towards evaluating learning outcomes expressed in terms of competencies.
Final assessment method	Bachelor's Degree exam, defence of the Bachelor's Degree thesis
Certification	Bachelor's degree
Title awarded	BSc engineer
Rights for graduates	Apply for master degree programmes; Apply for continuous training programmes; Employment.
Body responsible for authorizing programmes	Ministry of Education, ANACIP

2.1.3 Competences developed under the study programme

The professional competences developed under the study programme are determined by the definition of the Software Engineering specialty in accordance with the standard ACM - Association for Computing Machinery and the IEEE Computer Society (2015) and require a mix of skills to solve some categories of problems outlined by key competences through:

- scientific and engineering fundamentals of information technologies;
- organizational and informational aspects of the systems;
- application technologies;
- software development methods and technologies;
- architecture and infrastructure of computing systems.

The professional and transversal competences are covered by fundamental, general, socio-humanistic and specialty disciplines, the weighting of which is in line with the framework plan (Normative acts, Framework Plan for Higher Education, 2015). Explained competences as well as their distribution on content areas can be consulted in the grids of Annexes 3 and 4.

2.1.4 Employability of graduates

Taking into account the increasing need of qualified specialists on the national and regional market, TUM graduates have a high rate of employability, in line with the USAID survey. The Classification of Occupations of the Republic of Moldova approved on 03.03.2014 by the Government of the Republic of Moldova through the major subgroup 25 Specialists in information technology and communications with the minor group 251 Programmers analysts in the field of software (2511 System analysts, 2512 Software designers, 2513 Web and multimedia system designers, 2514 Application programmers, 2519 Software programmer analysts not classified in the previous core groups) covers the core functions / professions of the graduates from the Software Engineering programme.

Taking into account the competences of the programme, software engineers are able to occupy other functions than those mentioned: from teachers and researchers to executives and managers of different levels.

2.1.5 Further training opportunities

The Software Engineering study programme through the stated competences necessary to be achieved allows graduates to continue in their master's degree in ICT specialties at any university in the country and abroad within existing national and international partnerships.

2.1.6 Methods and criteria for assessing competences

The minimum standards for the assessment of competences are presented in the grid 1L [Annex 4], the key assessment methods comprising: papers, laboratory works for engineering skills training, projects with individual tasks or teamwork with practical completion, tests / exams, exam and a bachelor's degree thesis.

The criteria for the assessment of competences, in accordance with the Regulation for the organization of studies in higher education based on SNCS (Order ME 726 of 20.09.2010), are established by the norms of the institution. Thus, the Regulation on the organization of the evaluation of students' learning activity (Order of TUM's Rector, entered into force in 2011/2012) by paragraph 2.3 The evaluation criteria describes in detail the general and specific assessment criteria (to which may be added attitudinal and motivational aspects).

2.1.7 Rules of academic promotion

Promotion in the next year of study is conditioned by the accumulation of the number of compulsory credits foreseen in the educational plan during the academic year. Obtaining allocated credits is only possible with the "5" to "10" grades, according to the grading scale found in the Regulation on the organization of the assessment of students' learning activity.

In order to obtain the Bachelor's degree, it is necessary to fully complete the educational plan and to promote the evaluation tests (including the Bachelor's degree exam and the defence of the Bachelor's degreethesis) with at least the grade "5".

2.1.8 Expected learning outcomes

The study programme in Software Engineering trains engineers who have to demonstrate the following qualities:

- Have knowledge and skills of software engineering, know the professional standards required to start the engineering practice;
- Demonstrate understanding and can apply theories, models and techniques that define the foundations for identifying, analyzing, designing, realizing, implementing, checking and documenting the problems of the field;
- Can work both on their own and in team to develop and deliver quality software products;
- Demonstrate understanding, and give importance, for negotiation, leadership and communication with beneficiaries, indispensable components to a typical software development environment;
- Can provide solutions for various application domains using software engineering methods integrating ethical, social, legal and economic aspects;
- Can find acceptable solutions, matching contradictory objectives of the project, taking into account costs, time, knowledge, and existing systems.

Therefore, as expected outcomes of the study programme 0613.3 Software Engineering, it is expected that young specialists, holders of the title of BSc engineer, will demonstrate the transversal and professional knowledge, skills and competences corresponding to the requirements of the employers, confirmed by the degree with 240 transferable credits and providing employment opportunity and / or continuing studies in the second cycle (Master's degree studies).

2.2 SEMESTERS

The distribution of disciplines on areas of knowledge, their grouping on professional competences, establishing interdependence relations are presented in Annex 4. The following is a grouping of disciplines on semesters defining a common theme.

2.2.1 Semester 1

The theme of the introductory semester is *Problem-based learning of science, technology and society.*

The content areas covered by semester disciplines are: Exact and applied sciences

– 10 ECTS, General and socio-humanistic areas – 9 ECTS, Programming – 5 ECTS, Software development – 4 ECTS, Information management – 1 ECTS, Architectures, platforms and technologies – 1 ECTS.

The semester project is awarded 10 ECTS and is carried out in the module *Conceptual design of an IT application*. Course units related to semester projects are Computer programming and *Personal and professional development / Computer science and society*.

Code	Module / course unit name	Total hours			Number of hours by type of activity			Assessment form	No. credits
		total	direct contact	individual study	course	Internships	project		
G.01.O.013	Conceptual design of an IT application	300	150	150			150	PA	10
F.01.O.001	Mathematics	150	75	75	45	30		E	5
F.01.O.002	Computer programming	150	75	75	30	15	30	E	5
F.01.O.003	Special mathematics 1	150	75	75	30	45		E	5
U.01.A.021 *U.01.A.022*	Personal and professional development *Computer science and society*	150	75	75	30	30	15	E	5
	Total semester 1:	**900**	**450**	**450**	**135**	**120**	**195**	**4E, 1PA**	**30**
					450				

2.2.2 Semester 2

The theme of the semester is the *Engineering and scientific basis of computation*. The areas of content covered by the semesters are: Exact and applied sciences - 15 ECTS, Programming - 6 ECTS, Architectures, platforms and technologies - 5 ECTS, General and socio-humanistic fields - 4 ECTS.

The semester project is awarded 10 ECTS and is made under the *Equivalent models* module. Course units related to the semester project are *Applied sciences, Special mathematics 2* and *Data structures and algorithms*.

Code	Module / course unit name	Total hours			Number of hours by type of activity			Assessment form	No. credits
		total	direct contact	individual study	course	Internships	project		
F.02.O.004	Equivalent models	300	150	150			150	PA	10
F.02.O.005	Applied sciences	150	75	75	30	15	30	E	5
F.02.O.006	Special mathematics 2	150	75	75	30	15	30	E	5
F.02.O.007	Computer architecture	150	75	75	30	45		E	5
F.02.O.008	Data structures and algorithms	150	75	75	30	30	15	E	5
	Total semester 2:	**900**	**450**	**450**	**120**	**105**	**225**	**4E, 1PA**	**30**
					450				

2.2.3 Semester 3

Theme of the semester *The basics of applications development*. The content areas covered by the semesters are: Programming - 13 ECTS, Software development - 4 ECTS, Networks and data communications - 3 ECTS, Architectures, platforms and technologies - 2 ECTS, Exact and applied sciences - 2 ECTS, Information management - 3 ECTS, General and socio-humanistic fields - 3 ECTS.

The semester project is awarded 10 ECTS and is carried out under the *Equivalent models* module. Course units related to the semester project are *Applied sciences, Special mathematics 2* and *Data structures and algorithms.*

Code	Module / course unit name	Total hours			Number of hours by type of activity			Assessment form	No. credits
		total	direct contact	individual study	course	internships	project		
S.03.O.027	The Basics of Applications Development	300	150	150			150	PA	10
S.03.O.028	Object Oriented Programming	150	75	75	30	15	30	E	5
S.03.O.029	Computer networks	150	75	75	30	45		E	5
S.03.O.030	Databases	150	75	75	30	15	30	E	5
S.03.A.039 *S.03.A.040*	Data analysis and visualization *Computer graphics*	150	75	75	30	30	15	E	5
	Total semester 3:	**900**	**450**	**450**	**120**	**105**	**225**	**4E, 1PA**	**30**
					450				

2.2.4 Semester 4

Theme of the semester *Formal Languages and Compilers*. The content areas covered by the semester are: Software Development - 1 ECTS, Programming - 18 ECTS, Architectures, Platforms and Technologies - 8 ECTS, General and Socio-Humanistic Fields - 3 ECTS.

The semester project is awarded 10 ECTS and is realized within the module *Development of domain specific languages*. Course units related to semester project are *Formal Languages and Compiler Design*, *Computability and Complexity* and *Multimedia Technologies / Simulation and Modeling Techniques*.

Code	Module / course unit name	Total hours			Number of hours by type of activity			Assessment form	No. credits
		total	direct contact	individual study	course	Internships	Project		
F.04.O.009	Developing domain-specific languages	300	150	150			150	PA	10
F.04.O.010	Formal languages and compiler design	150	75	75	30	15	30	E	5
F.04.O.011	Computability and complexity	150	75	75	30	15	30	E	5
S.04.O.031	Operating systems: internal mechanisms and design principles	150	75	75	30	45		E	5

S.04.A.041 *S.04.A.042*	Multimedia technologies *Simulation and modeling techniques*	150	75	75	30	30	15	E	5
	Total semester 4:	**900**	**450**	**450**	**120**	**105**	**225**	**4E, 1PA**	**30**
					450				

Production internship (to be made at student's choice based on modules Basics of applications development and Development of domain-specific languages)

2.2.5 Semester 5

Theme of the semester *Networks and Security.* The content areas covered by the semesters are: Programming - 10 ECTS, Software Development - 6 ECTS, Exact and Applied Sciences - 1 ECTS, Information Security - 4 ECTS, Software Quality - 3 ECTS, General and Socio-Humanistic Fields - 6 ECTS.

The semester project is awarded 10 ECTS and is realized within the module *Developing Secure Applications.* Course units related to the semester project are *Network programming, Cryptography and Security,* and *Techniques and Software Design Mechanisms / Programme Verification and Validation.*

Code	**Module / course unit name**	**Total hours**			**Number of hours by type of activity**			**Assessment form**	**No. credits**
		total	**direct contact**	**individual study**	**course**	**internships**	**project**		
S.05.O.032	Developing secure applications	300	150	150			150	PA	10
S.05.O.033	Network programming	150	75	75	30	15	30	E	5
S.05.O.034	Cryptography and security	150	75	75	30	15	30	E	5
G.05.O.020	Ethics, communication and law	150	75	75	45	30		E	5
S.05.A.043 *S.05.A.044*	Techniques and mechanisms of software design *Verification and validation of programme products*	150	75	75	30	30	15	E	5
	Total Semester 5:	**900**	**450**	**450**	**135**	**90**	**225**	**4E, 1PA**	**30**
					450				

2.2.6 Semester 6

The theme of the semester *Internet of Things (IoT).* The content areas covered by the semester's disciplines are: Programming - 13 ECTS, Networks and data communications - 1 ECTS, Architectures, platforms and technologies - 8 ECTS, Exact and Applied Sciences - 5 ECTS, General and Socio-Humanistic fields - 3 ECTS.

The semester project is awarded 10 ECTS and is implemented within the *IoT Projects* module. All course units of the semester are related to the semester project, accumulating 255 hours of study guided by the supervisor.

Code	Module / course unit name	Total hours			Number of hours by type of activity			Assessment form	No. credits
		total	direct contact	individual study	course	internships	project		
S.06.O.035	IoT projects	300	150	150			150	PA	10
S.06.O.036	Embedded systems	150	75	75	30	15	30	E	5
F.06.O.012	Signal processing	150	75	75	30	30	15	E	5
S.06.A.045 *S.06.A.046* *S.06.A.045* *S.06.A.046*	Man-computer interaction *Real time programming*	150	75	75	30	15	30	E	5
S.06.A.047 *S.06.A.048*	Mobile application programming *Web programming*	150	75	75	30	15	30	E	5
	Total semester 6:	**900**	**450**	**450**	**120**	**75**	**255**	**4E, 1PA**	**30**
					450				

Technological internship (to be made at student's choice based on Secure Applications Development modules, semester 5, or IoT Projects, semester 6)

2.2.7 Semester 7

Theme of the semester *Information Systems.* The content areas covered by the semester's disciplines are: Programming - 8 ECTS, Software Development - 4 ECTS, Software Quality - 5 ECTS, Exact and Applied Sciences - 4 ECTS, Information Management - 2 ECTS, General and Socio-Humanistic fields - 7 ECTS.

The semester project is awarded 10 ECTS and is realized in the module *Information Systems Design*. All course units of the semester are related to the semester project, accumulating 225 hours of study guided by the supervisor.

Code	Module / course unit name	Total hours			Number of hours by type of activity			assessment form	No. credits
		total	direct contact	individual study	course	internships	project		
S.07.O.037	Design of information systems	300	150	150			150	PA	10
S.07.O.038	Programming Distributed Applications	150	75	75	30	15	30	E	5
U.07.A.023 *U.07.A.024*	Software Project Management *Company Management*	150	75	75	30	30	15	E	5
U.07.A.025 *U.07.A.026*	Electronic marketing *Digital entrepreneurship*	150	75	75	30	30	15	E	5
S.07.A.049 *S.07.A.050*	Software quality *Analysis and specification of software requirements*	150	75	75	30	30	15	E	5
	Total semester 7:	**900**	**450**	**450**	**120**	**105**	**225**	**4E, 1PA**	**30**
					450				

2.2.8 Semester 8

Theme of the semester *The bachelor's degree project.* The content areas covered by the semester's disciplines are: Programming - 12 ECTS, Software Development - 12 ECTS, Information Management - 2 ECTS, General and Socio-Humanistic Fields - 4 ECTS.

The semester is dedicated to the bachelor's degree project, which is given 15 ECTS. The project will be publicly defended in front of a commission with at least one external examiner, and the chairman of the bachelor's degree commission.

Code	Module / course unit name	Total hours			Number of hours by type of activity			assessment form	No. credits
		total	direct contact	individual study	course	internships	project		
S.08.A.051 *S.08.A.052*	Fundamentals of Artificial Intelligence *Unrelated databases*	150	75	75	30	45		E	5
S.08.A.053 *S.08.A.054*	Fundamentals of Game Development *Mixed reality technologies*	150	75	75	30	45		E	5

S.08.O.055	Internship and bachelor's degree project	450		450				E	15
S.08.O.056	Theoretical synthesis test: *Algorithms, programming and databases*	120		120				E	4
S.08.O.057	Defence of the bachelor's degree project	30		30				E	1
	Total semester 8:	**900**	**150**	**750**	**60**	**90**		**5E**	**30**
					150				

3. Roadmap

3.1 Introduction

The Roadmap [Annex 7] is a consolidated list of measures, commitments and timelines for implementing actions to overcome the challenges identified in the "Software Engineering" pilot study programme for implementing Problem Based Learning. Its purpose is to establish an institutional foundation to overcome certain barriers or certain threats to the implementation of the project in question.

In order to implement the pilot study programme, the Roadmap was developed [Annex 7]. This includes several activities required to be implemented at the institutional level in order to successfully implement the "Software Engineering" pilot study programme. The implementation of this Action Plan has already begun, some activities being carried out, others being started. These activities could formally be divided into three periods:

Period 1: Preparation process.
Period 2: Implementation process.
Period 3: Promoting.

3.2 PERIOD 1

Period 1: The duration of the period is up to 2 years (2015 - summer 2017) and the goal is to prepare the legal framework, the physical environment and the teaching staff for the launch of the new "Software Engineering" study programme.

In order to start the learning process under the new "Software Engineering" study programme, the following steps need to be taken:

1. The Software Engineering specialty is a new specialty that is not in the *Nomenclature of Professional Training Areas and Specialties of 2005*, which is why it must be introduced and approved in the new *Nomenclature of Professional Training Areas and Specialties of 2017*.
2. Elaboration of the educational plan for the training of the specialist in Software Engineering according to the provisions of the *TUM's Regulation regarding the organization of studies based on the National Study Credits System*, having regard to the *Regulation for the organization of studies in higher education based on the National Study Credits System*, so that the programme is linked to national and international standards of training of specialists in the field and corresponds to the Framework Plan.
3. Approval of the Study Programme within the Software Engineering and Automatics Department; Faculty of Computer Science, Informatics and Microelectronics and TUM Senate.
4. The internal evaluation (self-evaluation) of the study programme for authorization of provisional functioning shall be carried out autonomously by the Technical University of Moldova.

5. The advertising of the new study programme through leaflets [Annex 9], the website of the Technical University of Moldova (http://utm.md/studii/planuri/2016/fcim/Plan%20ISW.pdf), social networks.
6. Based on the Order of the Ministry of Education of the Republic of Moldova on the organization of the admission 2017, admission to the Software Engineering specialty (http://utm.md/admitarea-utm/admiterea-utm-licenta/).

Content change:

The launch of the new study programme envisages certain activities aimed at modifying the paradigm of higher education, namely:

1. Elaboration of the new educational plan, which corresponds to the Framework Plan and is based on a linear progress determined by relations at the semester level rather than at the level of disciplines.
2. Identifying companies that will assume support to provide knowledge transfer support at the content level, teachers and internship placements for students.
3. Preparing the infrastructure for teaching based on the PBL methodology consists in procuring the equipment and preparing the lecture halls, which will be team-oriented.
4. Identifying the teachers who will be involved in the teaching process within the new study programme and preparing them for the use of the PBL teaching methodology.
5. Elaboration of educational documents: curriculum by disciplines (analytical programmes), fact sheets, guides, case studies, evaluation etc. (for the first year of study).

3.3 PERIOD 2

The implementation period foresees the launch of the new study programme from 1 September 2017.

The new study programme is launched on the basis of an educational plan that is based on a linear progress determined by relationships at the semester level rather than at the level of disciplines. Each semester has a well-defined theme and a supervisor (tutor) who coordinates the activities of teachers and students:

- Learning based on science, technology and society problems
- The engineering and scientific basics of the calculation
- The basics of applications development
- Formal languages and compilers
- Networks and security
- The Internet of Things (IoT)
- Information systems
- Bachelor's degree project.

Unique themes conclude the modules of the semester (courses / lectures, seminars, other activities), giving them a common sense, a motivation to study. To which is added the semester project, which is given 10 ECTS credits (out of 30 per semester) and the other recommended subjects - other 20. The approach allows the decongestion of the study programme from the modules offered

by the department (compulsory or optional) and the offering of greater academic freedom for students in projects, in the spirit of PBL principles.

This period also provides for an external evaluation of the study programme for the provisional authorization by the National Agency for Quality Assurance in Professional Education (ANACIP).

The external evaluation commission shall verify, through a visit to the requesting institution, the fulfillment of requirements with respect to accreditation standards, performance criteria and performance indicators, approved by ANACIP. If all accreditation standards "meet the requirements", the Governing Board of ANACIP proposes to ***authorize the provisional functioning*** of the study programme for a period of five years.

The final decision on the authorization or non-authorization of provisional functioning is adopted: by Government Decision, at the proposal of the Ministry of Education, based on the decision of the Governing Board of ANACIP.

3.4 PERIOD 3

This period implies the promotion of the ERASMUS + PBLMD project and the new Software Engineering study programme.

The promotion plan of the project and the study programme is presented in Annex 10.

4. ACTION PLAN

4.1 INTRODUCTION

The Action Plan represents the activities undertaken to launch the new Software Engineering study programme at the Faculty of Computer Science, Informatics and Microelectronics, Annex 6.

4.2 ACTIVITIES

4.2.1 Period 1

Activities related to the development of the educational offer. During their elaboration, the experience gained during the visits to the partner universities of the European Union (Aalborg University of Denmark, University of Glasgow, UK) and the legislative and normative acts regulating the activity in higher education in the Republic of Moldova were taken into account.

4.2.2 Period 2

Activities related to the training of the teachers in order to use the PBL method. In this respect, a part of the teaching staff, who provide lectures in the respective groups, were and are involved in the trainings organized at TUM. Also, several teachers have benefited from academic mobility at the European Universities of the European Union (assoc. prof., PhD, Dumitru Ciorba; assoc. prof., PhD, Cojuhari Elena; assoc. prof., PhD, Cojuhari Irina, etc.), where they had the opportunity to get acquainted with the PBL teaching methodology.

4.2.3 Period 3

Activities related to the preparation of the legal framework, elaboration of the educational plan for the training of the specialist in Software Engineering, approval of the study programme at department, faculty and the TUM Senate levels.

Development of the curriculum on disciplines (analytical programmes), guides, case studies, evaluation, etc. Identifying companies that will assume support to provide knowledge transfer support at the level of content, teaching staff and internship placements for students.

4.2.4 Period 4

Preparing the infrastructure for teaching based on the PBL methodology consists in procuring the equipment and opening the PBL rooms within the Faculty of Computer Science, Informatics and Microelectronics.

4.2.5 Period 5

Activities related to the dissemination of good practice. In this respect, TUM's newspaper "Mesager Universitar" will be used in which will be published information about the project implementation, with the participation of the project team members with speeches at various conferences, workshops. At the same time, activities under the SI study programme are also reflected on facebook.com.

4.2.6 Period 6

Extension of PBL for other specialties within TUM.

5. POLICY RECOMMENDATIONS

5.1 INTRODUCTION

The implementation of the PBLMD project highlighted some *important aspects* of the developed study programme, which are listed below in the perspective of the SWOT analysis (and which can define the plan of measures needed to develop the programme at institutional levels):

Aspects	Notes
Strengths (internal source)	
TUM is an institution with traditions	*Transfer of authority and well-established processes*
Recognized for good training	*The USAID Survey*
Internationalization actions	*Plan created in the spirit of the international ACM standard* *Programmes in English*
Teachers with good professional experience	*There are also teachers employed in IT companies*
Large number of students	*The relatively higher number of students offers opportunities to optimize the didactic workload*
Alternatives to education	*Interdisciplinary approach, teamwork, etc.*
Experience with Anglophone groups	*The existence of the Anglophone students community, which allows multiple extra-curricular activities*
Weaknesses (internal source)	
Few teachers have PhD degrees	*Diminishes the academic value of the programme evaluation*
Few teachers speak English fluently	
Few teachers involved in research topics	*Decreases from the scientific value of the programme evaluation*
Uncompetitive salary to an IT teacher compared to a specialist in the field	*The difference between the salary of a beginner in the field and a teacher becomes significant*
Insufficient technical endowment to cover new directions	*The local industry is already actively seeking for IoT, VR, GameDev, etc. specialists*
Insufficient use of institutional collaboration relationships with IT associations / companies	*Programme engagement, technical endowment, etc*
Opportunities (external source)	
Internationalization of the study programme	*Cooperation agreements* *Academic mobility through programmes, like Erasmus +*
External financing for technical means	*The PBLMD project* *Collaboration USAID - IoT Laboratory* *Collaboration Orange - Mobile Technologies*
Internships / workshops for staff training	
IT career promotion campaigns of domain affiliated associations	*I Choose a Career in IT (ATIC)*
Required professional field (dynamic sector in RM)	*Admission contest* *Extensive internship / collaboration base*

Aspects	Notes
Threats (external source)	
Reducing the number of high school graduates	*Especially from those with a real profile*
Migration of students after the beginning of the study year	*In particular, Romania*
Confusions with related specialties	*Information Technologies, Informatics, Computers, Automatics*
Competition with "accelerated studies" training IT specialists	*Continuous training programmes, ...*
Worsening of the social-political situation in the country	*Decrease in budget funding* *Retaining salaries and scholarships*

5.2 STUDY PROGRAMME LEVEL

At the basis of the organization of the educational process are: educational standards, the nomenclature of specialties, educational plans and study programmes.

The university departments have a conventional independence in the development of the educational plans for the study programmes initiated, which results from the institutional organization and higher education studies in the Republic of Moldova. However, some actions can be done at departmental level:

Recommendations	Planned measures
Continuous adaptation of study programmes and content of course units to the needs of students and society	- Using the best teaching and examination methods based on the experience and specificity of our university (intensifying the use of new e-learning technologies). - Strengthening the groups of disciplines depending on the areas of knowledge and identifying supervisors of competences to ensure consistency in the flow of studies. - Using non-formal education methods (through workshops, meetings with specialists in the field / former graduates). - Developing the transversal skills needed for a successful ICT employee. - Consultation of businesses and economic agents on the content of the educational plans.

5.3 DEPARTMENT AND FACULTY LEVELS

The faculties (according to the TUM Statute) are university didactic-scientific and administrative subdivisions, which aim at organizing and carrying out the training-education process in the first cycle (Bachelor), the second cycle (Master) and the third cycle (PhD), continuous education of engineering staff, carrying out methodical, educational and scientific research, innovation and development for one or more fields / specialties / specializations. The organizational structure of the faculty includes departments, teaching and scientific laboratories, centers and other subdivisions.

The department / chair is the functional academic unit that assures the production, transmission and capitalization of knowledge in one or more training / specialty fields.

At the department and faculty level, the following recommendations and measures are proposed:

Nr. crt.	Recommendations	Planned measures
1	Active involvement in the activity of teacher training and increase of the number of staff holding scientific degrees and scientific-didactic titles.	- Didactic staff training within the PBL pedagogical module. - More teachers enrolled in English courses organized by TUM for teachers. - Internships / workshops for staff training. - Continuous training of teaching staff. - Organization of the basis for more active involvement of teachers in the research process. - Conducting scientific seminars at the department. - Carrying out didactic seminars with the sharing of teaching experience based on the PBL methodology.
2	Active involvement of teachers in research with wider involvement of students in the scientific research process.	- Consolidation of the scientific research directions carried out within the department in research groups. - Orientation of departmental research directions to Horizon 2020 priority research themes. - Attracting students to scientific activities.
3	Promoting the image of the department and study programme	- Career promotion campaigns. - Internationalization of the study programme. - Strengthening academic partnerships. - Promoting the image of the department.
4	Developing the technical and material basis for laboratory work and scientific research.	- Finanțare externă pentru mijloace tehnice. - *External financing for technical means.* -Îmbunătățirea infrastructurii de predare și de cercetare. - *Improving the teaching and research infrastructure.*
5	Expanding the area of internship placements.	- Concluding new collaboration protocols with businesses to ensure student placements. - Mobility programmes for students.

5.4 STAFF LEVEL

At the staff level, the following recommendations and measures are proposed:

Nr. crt.	Recommendations	Planned measures
1	Active involvement in continuous training.	- Training within the pedagogical training module PBL. - More teachers enrolled in English courses organized by TUM for teachers. - Internships / workshops for staff training. - Continuous training courses.
2	Active involvement in the research process.	- Active involvement of teaching staff in the research process. - Active participation in scientific seminars organized within the department.

5.5 Administration and management levels

The executive manager of TUM is the Rector, who legally represents TUM in relations with third parties and runs the University.

The governing structures in TUM are:

a) at university level: the University Senate, the Institutional Strategic Development Council, the Scientific Council and the Administration Council of the University;
b) The faculty council;
c) Department council;
d) the structure of student self-government;
e) Council of the Doctoral School.

At the level of administration and management, the following recommendations and measures are proposed:

Nr. crt.	Recommendations	Planned measures
1	Developing the technical and material basis for laboratory work and scientific research.	- External financing for technical means. - Facilities adapted for active learning.
2	Planning PBL education in other study programmes.	- Identifying study programmes and providing support for the legal framework, infrastructure.
3	Expanding institutional collaboration relationships with IT associations / companies.	- Concluding new collaboration agreements with IT Associations / Companies.

6. CONCLUDING REMARKS

The educational system in the Republic of Moldova works by inerting a traditional framework in which education is regarded as a production process. The production of prepared and disciplined staff according to standardized educational processes. This approach fits perfectly into a fully industrialized society, but not in a post-industrialized one that faces great socio-economic challenges. The need for change in society is also fully reflected in education, where the curriculum appears as a transformation of an effort (individually and collectively) into the skills necessary for society. The objectives of any current programme target these characteristics for an employee. But these not being practiced, not being part of the learning model, can not be fully achieved. Therefore, another learning model, a reorganization of the interdisciplinary study programme (achieved through real projects), flexibility (provided by information technologies) and freedom (to choose the problem individually depending on individual capacities and interests) (Balan, Calin, & Ciorba, 2016) is required.

Student centered teaching methods change the focus of activity from teacher to student. These methods include active learning where students solve problems, ask questions, formulate their own questions, discuss, explain, discuss or suggest brainstorming sessions during the lesson; collaborative learning, where students work in teams on problems and projects under conditions that ensure both positive interdependence and individual responsibility; inductive teaching and learning, where students are first presented with the challenges (questions or problems) and then they have to learn the course material in the context of solving the challenges.

Problem Based Learning (PBL) is an approach that encourages active learning through the creation of environments and tasks offered by social-constructivist learning theory (Karami, Karami, & Attaran, 2013). Active learning is generally defined as any training method that involves students in the learning process. In other words, active learning requires students to make meaningful learning activities and think about what they are doing. The basics of active learning are student activity and involvement in the learning process. Active learning is often in contrast to the traditional lesson where students passively receive information from the teacher (Prince, 2004).

There are different implementation models for PBL, but in the context of software engineer training, the experience in (Zapater, Malagon, Goyeneche, & Moya, 2013) is worth mentioning. The authors used the SCRUM methodology, widely used in the software industry, in an experimental group of students. Therefore, in addition to pedagogical objectives, students were also required to learn version control tools (to share code between teammates), divide complex tasks into smaller ones, analyze and measure the time required for each task, develop communication skills to ensure effective interaction with their colleagues. Qualitative and quantitative analyzes of Agile-PBL experiences results versus traditional methodologies have shown students' satisfaction and motivation. However, the same measurements show that there are negative effects related to the additional planning and coordination time (planning overhead) and the tools imposed in use. The key conclusion is that information technologies must be an ally in gaining freedom in learning and not a new constraint.

A society can only be free and democratic if every individual is free and responsible in his/her choices. These important qualities a man only achieves by "practicing" them, being placed at the center of the learning context. Education in this sense can be understood as a framework for creating the best conditions for personal development (Illeris, 2007; Balan, Călin, & Ciorbă, 2016).

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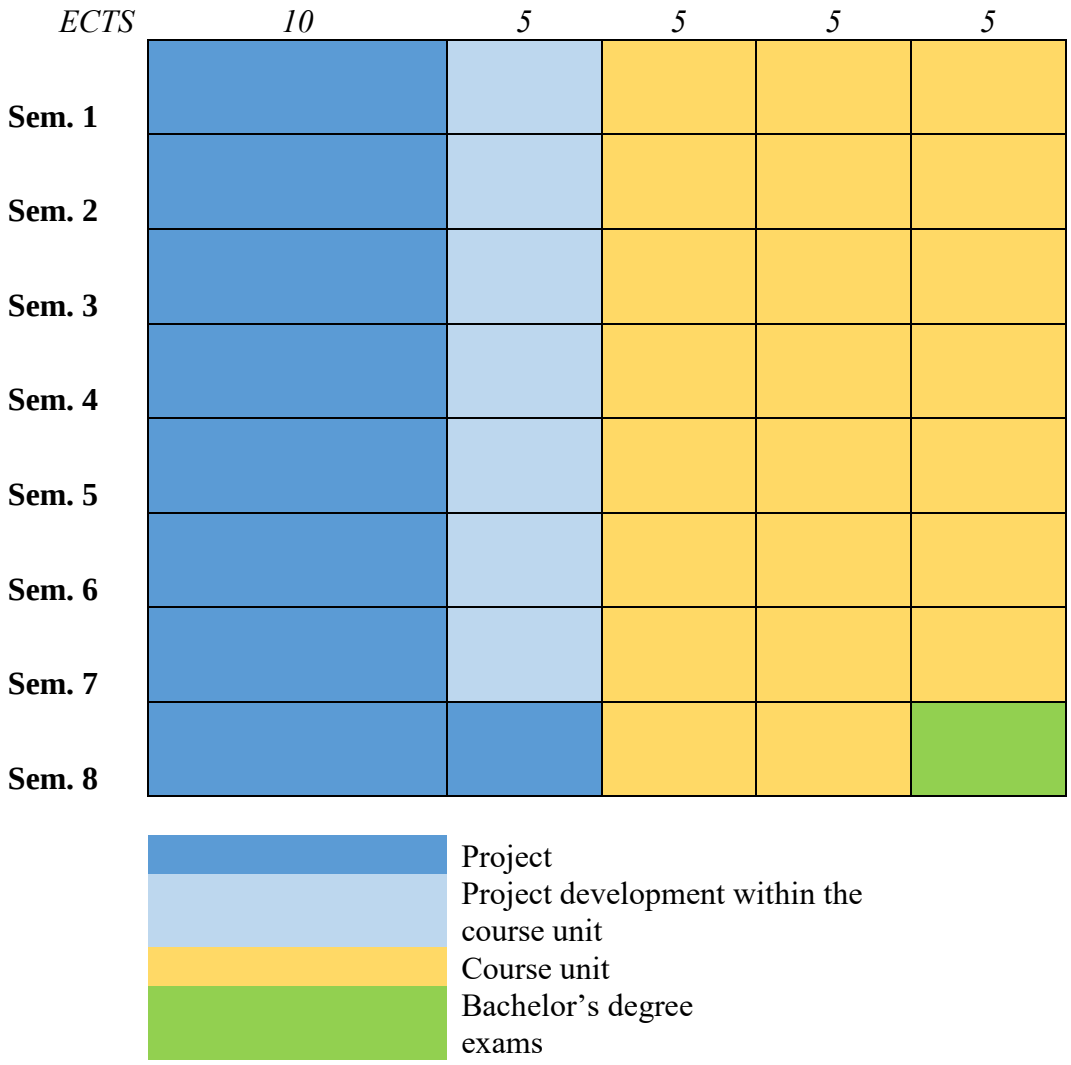
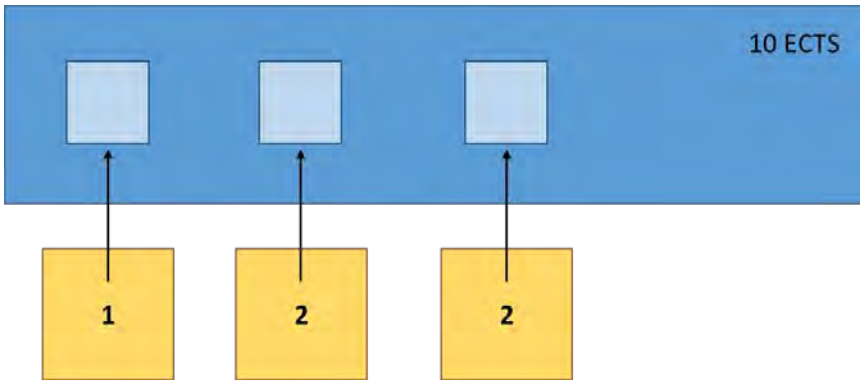
Annex 1: Our vision on the Bachelor's Degree Programme





Credits distribution model within three course units

Annex 2: Bachelor`s Degree Programme on Softaware Engineering

Ministerul Educaţiei al Republicii Moldova
Universitatea Tehnică a Moldovei
Facultatea Calculatoare, Informatică şi Microelectronică

„APROBAT"
Şedinţa Senatului UTM
proces verbal nr. 4
din *„27" decembrie 2016*
Preşedintele Senatului UTM
Rector, dr. hab.
Viorel Bostan

„COORDONAT"
Ministerul Educaţiei al Republicii Moldova
„ 04 " 04 2017
nr. de înregistrare 932-01-18130

PLAN DE ÎNVĂŢĂMÂNT
pentru ciclul I, studii superioare de licenţă (nivelul 6 conform ISCED)

Domeniul general de studiu: *061 Tehnologii ale informaţiei şi comunicaţiilor*
Domeniul de formare profesională: 0613 Dezvoltarea produselor program şi a aplicaţiilor
Programul de studiu: 0613.3 Ingineria software
Nr. total de credite de studiu ECTS: 240
Titlul conferit: Inginer licenţiat
Certificare: Diploma de licenţă
Baza admiterii : diploma de bacalaureat sau un act echivalent de studii;
diploma de studii superioare
Limba de instruire: română, rusă, engleză
Forma de organizare a învăţământului: învăţământ cu frecvenţă

1. CALENDARUL UNIVERSITAR

Anul de studii	*Activităţi didactice*		*Sesiuni de examene*		*Stagii de practică*	*Vacanţe*		
	Sem. I	*Sem. II*	*Sem. I*	*Sem. II*		*Iarnă*	*Primăvara*	*Vară*
I	15 săptămâni	15 săptămâni	4 săptămâni	4 săptămâni	-	2 săptămâni	Vacanţa pentru sărbătorile de Paşti, 1 săptămână (conform calendarului crestin)	10 săptămâni
II	15 săptămâni	15 săptămâni	4 săptămâni	4 săptămâni	15 săptămâni	2 săptămâni		6 săptămâni
III	15 săptămâni	15 săptămâni	4 săptămâni	4 săptămâni	15 săptămâni	2 săptămâni		6 săptămâni
IV	15 săptămâni	*7 săptămâni*	4 săptămâni	2 săptămâni	10 săptămâni	2 săptămâni		9 săptămâni

coordonat

Agenția Națională de Asigurare
a Calității în Educație și Cercetare

AFFILIATE OF
ENQA

CERTIFICAT

de evaluare externă a calității

Nr. 000117

eliberat Universității Tehnice a Moldovei, cu sediul în mun. Chișinău, bd. Ştefan cel Mare, 168, MD - 2004, înregistrată la Camera Înregistrării de Stat nr. 1007600001506 din 29 ianuarie 2007.

În baza rezultatelor evaluării externe, Consiliul de Conducere al Agenției Naționale de Asigurare a Calității în Educație și Cercetarea luat decizia nr. 15 din 23.02.2018 de acreditare a programului de studii superioare de licență *0613.3 Inginerie software, forma de învățământ cu frecvență* pentru o perioadă de 5 ani.

Președinte **Andrei CHICIUC**

Eliberat la 20 noiembrie 2018

Chișinău

2. Planul de învățământ pe semestre/ani de studiu

Anul I

Semestrul I — *Învățarea bazată pe probleme ale științei, tehnologiei și societății*

Cod	Denumirea unității de curs/modulului	Total ore			Numărul de ore pe tipuri de activități				Forma de evaluare	Nr. credite
		total	contact direct	studiul individual	C	S/P	Pr	pe săptă-mână		
G.01.O.013	Proiectare conceptuală a unei aplicații IT	300	150	150			150		PA	10
F.01.O.001	Matematica	150	75	75	45	30			E	5
F.01.O.002	Programarea calculatoarelor	150	75	75	30	15	30		E	5
F.01.O.003	Matematici speciale 1	150	75	75	30	45			E	5
U.01.A.021 *U.01.A.022*	Dezvoltarea personală și profesională *Știința calculatoarelor și societatea*	150	75	75	30	30	15		E	5
G.01.O.014	*Limba străină 1***	*90*	*45*	*45*		*45*			*E**	*3*
G.01.O.015	*Limba română (alolingvi) 1**	*60*	*30*	*30*		*30*			*T**	*2*
G.01.O.016	*Educație fizică 1**	*60*	*30*	*30*		*30*			*T**	
	Total semestrul I:	**900**	**450**	**450**	**135**	**120**	**195**	**0**	**4E, 1PA**	**30**
					450					

Semestrul II — *Bazele inginerești și științifice ale calculului*

Cod	Denumirea unității de curs/modulului	Total ore			Numărul de ore pe tipuri de activități				Forma de evaluare	Nr. credite
		total	contact direct	studiul individual	C	S/P	Pr	pe săptă-mână		
F.02.O.004	Modele echivalente	300	150	150			150		PA	10
F.02.O.005	Științe aplicate	150	75	75	30	15	30		E	5
F.02.O.006	Matematici speciale 2	150	75	75	30	15	30		E	5
F.02.O.007	Arhitectura calculatoarelor	150	75	75	30	45			E	5
F.02.O.008	Structuri de date și algoritmi	150	75	75	30	30	15		E	5
G.02.O.017	*Limba străină 2**	*90*	*45*	*45*		*45*			*E**	*3*
G.02.O.018	*Limba română (alolingvi) 2**	*60*	*30*	*30*		*30*			*T**	*2*
G.02.O.019	*Educație fizică 2**	*60*	*30*	*30*		*30*			*T**	
	Total semestrul II:	**900**	**450**	**450**	**120**	**105**	**225**	**0**	**4E, 1PA**	**30**
					450					
	Total anul I de studii:	**1800**	**900**	**900**	**255**	**225**	**420**	**0**	**8E, 2PA**	**60**

** - Nu se calculează în suma totală a formelor de evaluare (unitățile de curs se realizează în regim extracurricular și li se alocă credite suplimentar celor 240 de credite per program, iar unitatea de curs „Educația fizică" nu se cuantifică cu credite).*

T – Test, cu calificativul admis/respins.*

Anul II

Semestrul III — ***Bazele dezvoltării aplicațiilor***

Cod	**Denumirea unității de curs/modulului**	*Total ore*			*Numărul de ore pe tipuri de activități*				*Forma de evaluare*	*Nr. credite*
		total	*contact direct*	*studiul individual*	*C*	*S/P*	*Pr*	*pe săptă-mână*		
S.03.O.027	Bazele dezvoltării aplicațiilor	300	150	150			150		PA	10
S.03.O.028	Programarea orientată pe obiecte	150	75	75	30	15	30		E	5
S.03.O.029	Rețele de calculatoare	150	75	75	30	45			E	5
S.03.O.030	Baze de date	150	75	75	30	15	30		E	5
S.03.A.039 *S.03.A.040*	Analiza și vizualizarea datelor *Grafica pe calculator*	150	75	75	30	30	15		E	5
	Total semestrul III:	**900**	**450**	**450**	**120**	**105**	**225**	**0**	**4E, 1PA**	**30**
					450					

Semestrul IV — ***Limbaje formale și compilatoare***

Cod	**Denumirea unității de curs/modulului**	*Total ore*			*Numărul de ore pe tipuri de activități*				*Forma de evaluare*	*Nr. credite*
		total	*contact direct*	*studiul individual*	*C*	*S/P*	*Pr*	*pe săptă-mână*		
F.04.O.009	Elaborarea limbajelor specifice domeniului	300	150	150			150		PA	10
F.04.O.010	Limbaje formale și proiectarea compilatoarelor	150	75	75	30	15	30		E	5
F.04.O.011	Calculabilitate și complexitate	150	75	75	30	15	30		E	5
S.04.O.031	Sisteme de operare: mecanisme interne și principii de proiectare	150	75	75	30	45			E	5
S.04.A.041 *S.04.A.042*	Tehnologii multimedia *Tehnici de simulare și modelare*	150	75	75	30	30	15		E	5
	Total semestrul IV:	**900**	**450**	**450**	**120**	**105**	**225**	**0**	**4E, 1PA**	**30**
					450					
	Practica în producție (Se realizează la alegerea studentului pe baza modulelor *Bazele dezvoltării aplicațiilor* și *Elaborarea limbajelor specifice domeniului*)									
	Total anul II de studii:	**1800**	**900**	**900**	**240**	**210**	**450**	**0**	**8E, 2PA**	**60**

Anul III

Semestrul V — ***Rețele și securitate***

Cod	**Denumirea unității de curs/modulului**	*Total ore*			*Numărul de ore pe tipuri de activități*				*Forma de evaluare*	*Nr. credite*
		total	*contact direct*	*studiul individual*	*C*	*S/P*	*Pr*	*pe săptă-mână*		
S.05.O.032	Dezvoltarea aplicațiilor securizate	300	150	150			150		PA	10
S.05.O.033	Programarea în rețea	150	75	75	30	15	30		E	5
S.05.O.034	Criptografie și securitate	150	75	75	30	15	30		E	5
G.05.O.020	Etică, comunicare și drept	150	75	75	45	30			E	5
S.05.A.043 *S.05.A.044*	Tehnici și mecanisme de proiectare software *Verificarea și validarea produselor program*	150	75	75	30	30	15		E	5
	Total semestrul V:	**900**	**450**	**450**	**135**	**90**	**225**	**0**	**4E, 1PA**	**30**
					450					

Semestrul VI — ***Internetul lucrurilor (IoT)***

Cod	**Denumirea unității de curs/modulului**	*Total ore*			*Numărul de ore pe tipuri de activități*				*Forma de evaluare*	*Nr. credite*
		total	*contact direct*	*studiul individual*	*C*	*S/P*	*Pr*	*pe săptă-mână*		
S.06.O.035	Proiecte IoT	300	150	150			150		PA	10
S.06.O.036	Sisteme incorporate	150	75	75	30	15	30		E	5
F.06.O.012	Prelucrarea semnalelor	150	75	75	30	30	15		E	5
S.06.A.045 *S.06.A.046*	Interacțiunea om-calculator *Programarea în timp real*	150	75	75	30	15	30		E	5
S.06.A.047 *S.06.A.048*	Programarea aplicațiilor mobile *Programare web*	150	75	75	30	15	30		E	5
	Total semestrul VI:	**900**	**450**	**450**	**120**	**75**	**255**	**0**	**4E, 1PA**	**30**
					450					
	Practica tehnologică (Se realizează la alegerea studentului pe baza modulelor *Dezvoltarea aplicațiilor securizate* și *Proiecte IoT*)									
	Total anul III de studii:	**1800**	**900**	**900**	**255**	**165**	**480**	**0**	**8E, 2PA**	**60**

Anul IV

Semestrul VII

Sisteme informaționale

Cod	**Denumirea unității de curs/modulului**	***Total ore***			***Numărul de ore pe***				***Forma de evaluare***	***Nr. credite***
		total	***contact direct***	***studiul individual***	***C***	***S/P***	***Pr***	***pe săptă-mână***		
S.07.O.037	Proiectarea sistemelor informaționale	300	150	150			150		PA	10
S.07.O.038	Programarea aplicațiilor distribuite	150	75	75	30	15	30		E	5
U.07.A.023 *U.07.A.024*	Managementul proiectelor software *Managementul întreprinderii*	150	75	75	30	30	15		E	5
U.07.A.025 *U.07.A.026*	Marketingul electronic *Antreprenoriatul digital*	150	75	75	30	30	15		E	5
S.07.A.049 *S.07.A.050*	Calitatea software-ului *Analiza și specificarea cerințelor software*	150	75	75	30	30	15		E	5
	Total semestrul VII:	**900**	**450**	**450**	**120**	**105**	**225**	**0**	**4E, 1PA**	**30**
					450					

Semestrul VIII

Proiectul de licență

Cod	**Denumirea unității de curs/modulului**	***Total ore***			***Numărul de ore pe***				***Forma de evaluare***	***Nr. credite***
		total	***contact direct***	***studiul individual***	***C***	***S/P***	***Pr***	***pe săptă-mână***		
S.08.A.051 *S.08.A.052*	Fundamente ale inteligenței artificiale *Baze de date nerelaționale*	150	75	75	30	45			E	5
S.08.A.053 *S.08.A.054*	Fundamente ale dezvoltării jocurilor *Tehnologii de realitate mixtă*	150	75	75	30	45			E	5
S.08.O.055	Practica și proiectarea de licență	450		450					E	15
S.08.O.056	Proba teoretică de sinteză: *Algoritmi, programări și baze de date*	120		120					E	4
S.08.O.057	Susținerea proiectului de licență	30		30					E	1
	Total semestrul VIII:	**900**	**150**	**750**	**60**	**90**	**0**	**0**	**5E**	**30**
	Total anul IV de studii:	**1800**	**600**	**1200**	**180**	**195**	**225**	**0**	**9E, 1PA**	**60**
	Total la programul de studiu:	**7200**	**3300**	**3900**	**930**	**795**	**1575**	**0**	**33E, 7PA**	**240**

3. Stagiile de practică

Stagiile de practică*		Semestrul	Durata, săpt/ore	Perioada	Număr de credite
1	Practica în producţie	3/4	15	Septembrie-Decembrie/	10
2	Practica tehnologică	5/6	15	Februarie-Mai	10
3	Practica şi proiectarea de	8	10	Martie-Mai	15
Total:			**24/990**		**35**

** Stagiile de practică se efectuează în baza unui modul de proiectare semestrială*

4. Unităţi de curs la libera alegere (facultative)

Nr. crt.	Denumirea	Anul	Sem.	Numărul ore pe tipuri de activităţi pe săptămână			Evaluări	Număr de credite
				C	S/P	L		
1	Introducere în specialitate	1	2	30			E	2
2	Psihoinventica	2	4	30			E	2
3	Filozofia cognitivă	2	4	30			E	2
4	Reprezentarea grafică a datelor	3	5	30		30	E	4
5	Programarea în realitatea virtuală	3	5	30		30	E	4
6	Tehnici de inginerie inversă	3	6	30		30	E	4
7	Psihologia managerială	3	6	30			E	2
8	Guvernarea electronică	4	7	30			E	2
9	Limba română (alolingvi) 3	2	3		30		E	2
10	Limba română (alolingvi) 4	2	4		30		E	2
11	Limba română (alolingvi) 5	3	5		30		E	2
12	Limba română (alolingvi) 6	3	6		30		E	2
13	Limba străină 3	2	3		30		E	2
14	Limba străină 4	2	4		30		E	2
15	Limba străină 5	3	5		30		E	2
16	Limba străină 6	3	6		30		E	2
17	Limba străină 7	4	7		30		E	2
18	Educaţia fizică 3	2	3		30		T*	
19	Educaţia fizică 4	2	4		30		T*	
20	Educaţia fizică 5	3	5		30		T*	
21	Educaţia fizică 6	3	6		30		T*	
22	Educaţia fizică 7	4	7		30		T*	

T – Test, cu calificativul admis/respins.*

5. Examenul de licenţă

Nr. crt.	Denumirea activităţii	**Perioada**	**Număr de credite**
1	Proba teoretică de sinteză: *Algoritmi, programări si baze de date*	29.02. – 12.03	4
2	Susţinerea proiectului de licenţă	06.06. – 25.06	1
	Total:		**5**

Aprobat la şedinţa Senatului UTM, proces verbal nr. 4 din 27.12.2016

Ion BALMUŞ _____ Decanul Facultăţii CIM, conf. univ., dr.

Dumitru CIORBĂ _____ Şeful departamentului Ingineria Software şi Automatică conf. univ., dr.

MINISTERUL EDUCAȚIEI
AL REPUBLICII MOLDOVA
UNIVERSITATEA TEHNICĂ
A MOLDOVEI

MINISTRY OF EDUCATION
OF THE REPUBLIC OF MOLDOVA
TECHNICAL UNIVERSITY
OF MOLDOVA

MD-2004, CHIȘINĂU, BD. ȘTEFAN CEL MARE ȘI SFÂNT, 168, TEL: 022 23-78-61 | FAX: 022 23-54-41, www.utm.md

FACULTATEA CALCULATOARE, INFORMATICĂ ȘI MICROELECTRONICĂ

DEPARTAMENTUL INGINERIA SOFTWARE ȘI AUTOMATICĂ

Programul de studii superioare de licență

0613.3 Ingineria software

Chișinău 2016

NOTĂ EXPLICATIVĂ
la Planul de învățământ pentru studii superioare de licență (ciclul I)

Domeniului fundamental al științei, culturii și tehnicii: *06 Tehnologii ale informației și comunicațiilor*
Domeniului general de studiu: *061 Tehnologii ale informației și comunicațiilor*
Domeniul de formare profesională: *0613 Dezvoltarea produselor program şi a aplicațiilor*
Programului de studiu: *0613.3 Ingineria software*

Descrierea profilului specialității Ingineria software

Ingineria software (IS), alături de *Tehnologia Informației*, se încadrează în știința metodelor și instrumentelor de prelucrare a informației (*computing* – eng.) pentru soluționarea unor probleme specifice legate de organizarea activităților umane. În raport cu Tehnologia informației, programul *Ingineria software* are un caracter mai teoretic și orientat spre formarea de specialişti al căror misiune esențială este dezvoltarea de modele și tehnici pentru producerea de software, dar domeniul cărora se extinde atât spre infrastructura sistemelor, cât și spre aspecte organizaționale și informaționale ale întreprinderilor.

Aspectul mai teoretic al domeniului reiese din faptul că procedeele software de dezvoltare studiate au substrat teoretic mai bine fundamentat în programul de studii Ingineria Software.

Dar programul cuprinde și proceduri de aplicare a informației cu un scop specific în proiectarea, construirea și utilizarea produselor și serviciilor informatice, astfel existînd domenii comune cu programul Tehnologia Informației.

Descrierea domeniului de formare profesională în Ingineria Software

De la începuturile calculului electronic al anilor 40 sistemele de calcul și toate cele ce implică acestea au avut o rată de utilizare în continuă creștere. Software-ul deja definește elementele esențiale ale activităților umane: guvernare, comunicații, producere, bănci și finanțe, educație, transport, divertisment, medicină, agricultură și drept. Produsele software ajută lumea să fie mai eficientă, mai productivă. Datele OECD arată sumele imense cheltuite pe dezvoltarea de software. În ciuda acestor succese, în această perioadă au existat probleme serioase în ceea ce privește costurile de dezvoltare, promptitudinea și calitatea multor produse software. În ghidul curricular ACM se menționează mai multe motive pentru aceste probleme, definitorii pentru apariția noului program:

- Produsele software sunt printre cele mai complexe sisteme făcute de om, și prin însăși natura sa, software-ul are proprietăți intrinseci, esențiale, care nu sunt abordate cu ușurință;
- Tehnicile de programare care funcționează în echipe mici și pentru dezvoltarea de produse moderate nu mereu se potrivesc bine și pentru producerea sistemelor mari și complexe;
- Ritmul schimbărilor în domeniul TIC conduce spre produse noi și avansate. Prin urmare așteptările beneficiarilor și alte forțe motrice ale domeniului pun presiune pe dezvoltarea calitativă și în termen;
- Disponibilitatea de ingineri software calificați nu a ținut pasul cu cererea din industrie, astfel încât sistemele sunt proiectate și construite deseori de oameni fără o pregătire potrivită sau experiență.

Relevanța noului programului de studiu este oferită și de datele sondajului USAID (*Updating the IT skills gap* – O'Sullivan și Bercu, 2016), care scoate în evidență necesitatea în mai mulți specialiști calificați anume în dezvoltarea de produse program.

Ritmul înalt de globalizare a societății umane este în mare parte datorat tehnologiilor informaționale, care asigură noi oportunități de valorificare a informației. Recunoașterea acestui fapt este materializat în diverse acte naționale și internaționale:

- Agenda digitală *Europa 2020* face parte din cele șapte inițiative remarcabile în cadrul strategiei europene de dezvoltare durabilă și cuprinzătoare și are drept scop să aducă beneficii majore economice și sociale din partea unei piețe unice digitale, care deja spre mijlocul implementării trebuie să asigure: a) 50% de populație să utilizeze comerțul electronic; b) 33% din întreprinderi mici și mijlocii să realizeze vânzări online; c) 50% de cetățeni să beneficieze de servicii e-Guvernare; d) majoritatea serviciilor publice să fie accesibile online în toate țările membre ale UE etc.
- Transformarea Republicii Moldova într-un start modern și performant este posibilă doar prin *modernizarea tehnologică* la nivelul societății, al organizațiilor și al indivizilor (*acțiuni, regăsite și în Programul strategic de modernizare tehnologică a țării*).

Prin urmare ***scopul primar al programului de studiu*** *este determinat de necesitatea în ingineri bine pregătiți în corespundere cu domeniului de formare profesională, apți să ofere soluții și inovații avansate software aplicate diverselor domenii de activitate umană.*

Universitatea Tehnică a Moldovei, prin departamentul Ingineria Software și Automatică, este *prima universitate* care începând cu 1993 pregătește pentru economia națională ingineri licențiați în Tehnologii Informaționale. Dar consultările cu partenerii (instituții publice, companii private și studenți) au scos în evidență necesitatea în noi abordări: *lucru în echipă și interdisciplinaritate*.

Consultarea având un caracter continuu se manifestă prin activități de colaborare în cadrul diferitor seminare de lucru și proiecte inter-instituționale în care sunt implicați membrii departamentului. Printre companiile private care au colaborat activ în parteneriate de consultare sau de suport se pot enumera Orange, Starnet, Allied Testing, Endava, Pentalog, JMD Planet, Winify, Evisoft, TenerLab, Dekart.

Asigurarea calității educaționale

Calitatea activităților educaționale reprezintă prioritatea continuă a departamentului Ingineria Software și Automatică, în calitate de unitate furnizoare a multiplelor programe de studii: *Tehnologii Informaționale*, *Securitatea Informațională*, precum și *Automatică și Informatică*. Evaluarea calității consta în examinarea multicriterială a rezultatelor de studii exprimate în *cunoștințe, aptitudini și competențe*. Printre componentele de examinare se regăsesc următoarele:

- corespunderea cu Plan-cadrul pentru studii superioare (*aprobat prin Ordinul Min. Educație nr. 1045 din 29 octombrie 2015*),
- corespunderea cu standarde de referință (*Software Engineering 2014/ Curriculum Guidelines for Undergraduate Degree Programs in Software Engineering, Association for Computing Machinery (ACM), IEEE Computer Society*),
- conținutul și structura materiei predate – actualitatea științifică, integrarea rezultatelor de cercetare, dezvoltarea abilităților de a aplica cunoștințele în situați noi;

Asigurarea cu personal didactic

Profesorii noștri au reușit să participe în multiple activități științifice și didactice încadrate în proiecte *instituționale*, *naționale* și *internaționale*, colaborînd în ultimii ani cu cercetători ai instituțiilor similare din România, Rusia, Danemarca, Germania, Franța, Marea Britanie, Suedia, Israel etc. Caracterul multidisciplinar al domeniului include activitățile mai multor cercetători cu grade științifice implicați în programul de studiu:

Total unități de curs/module	Numărul de titulari de curs cu funcții de			
	Profesori universitari	Conferențiari universitari	Lectori universitari	Asistenți universitari
54	2	11	6 + 1 (cu grad științific)	-

Competențe dezvoltate de programul de studii și coordonarea dintre acestea și unitățile de curs/module

Competențele profesionale dezvoltate de programul de studiu sunt determinate de definiția specialității Ingineria Software în corespundere cu standardul *ACM - Association for Computing Machinery* și *IEEE Computer Society,* și presupun un mixaj de abilități pentru soluționarea unor categorii de probleme conturate prin *competențe-cheie* privind:

- fundamentele științifice și inginerești ale tehnologiilor informaționale ;
- aspectele organizaționale și informaționale ale sistemelor;
- tehnologiile aplicațiilor;
- metodele și tehnologiile de dezvoltare software;
- arhitectura și infrastructura sistemelor de calcul.

Competențele profesionale și transversale sunt acoperite de discipline fundamentale, generale, de orientare socio-umanistică și de specialitate, ponderile cărora sunt conformate Plan-cadrului. Explicitarea competențelor dezvoltate, precum și distribuirea acestora pe arii de conținut pot fi consultate în grilele din anexele 1 și 2.

Angajabilitatea absolvenților

Luând în calcul necesitatea crescândă în specialiști calificați pe piața națională și regională absolvenții UTM au o rată mare de angajabilitate, în conformitate și cu sondajul USAID. Clasificatorul Ocupațiilor din Republica Moldova aprobat în 03.03.2014 de Guvernul RM prin subgrupa majoră *25 Specialiști în tehnologia informației și comunicațiilor* cu grupa minoră *251 Analiști programatori în domeniul software* (2511 Analiști de sistem, 2512 Proiectanți de software, 2513 Proiectanți de sisteme web și multimedia, 2514 Programatori de aplicații, 2519 Analiști programatori în domeniul software neclasificați în grupele de bază anterioare) acoperă funcțiile/profesiile de bază ale absolvenților programului Ingineria Software.

Luînd în considerare competențele programului *inginerii software* sunt apți să ocupe și alte funcții decît cele menționate: de la profesori și cercetători la directori și conducători de diferit nivel.

Posibilitățile de formare ulterioară

Programul de studiu în Ingineria Software prin competențele declarate și necesare de a fi atinse permit absolvenților să continue studiile universitare de masterat la specialitățile domeniului TIC în orice universitate din țară și peste hotarele ei în cadrul parteneriatelor existente naționale și internaționale.

Metodele și criteriile de evaluare a competențelor

Standardele minimale de evaluare a competențelor sunt prezentate în grila 1L (anexa 1), metodele esențiale de evaluare cuprinzând: referate, lucrări de laborator destinate formării abilităților inginerești, proiecte cu sarcini individuale sau de lucru în echipă cu finalizare practică, teste/examene, examen și teză de licență.

Criteriile de evaluare a competențelor, în conformitate cu Regulamentul de organizare a studiilor în învățământul superior în baza SNCS (ordin ME 726 din 20.09.2010), sunt stabilite prin norme ale instituției. Astfel Regulamentul privind organizarea evaluării activității de învățare a studenților (ordin Rector UTM, intrat în vigoare a.u. 2011/2012) prin paragraful *2.3 Criterii de evaluare* descrie în detaliu criteriile generale și specifice de evaluare (la care se pot adăuga și aspecte atitudinale și motivaționale).

Reguli de promovare academică

Promovarea în următorul an de studii este condiționată de acumularea pe parcursul anului universitar a numărului de credite obligatorii prevăzute în planul de studiu. Obținerea creditelor alocate

este posibilă doar în cazul evaluării cu notele de la „5” până la „10”, conform scalei de notare regăsită în Regulamentul privind organizarea evaluării activității de învățare a studenților.

Pentru a obține diploma de licență este necesară realizarea integrală a planului de studiu și promovarea probelor de evaluare (inclusiv examenele de licență și susținerea proiectului de licență) cu cel puțin nota "5".

Finalități de studii preconizate

Programul de studiu în Ingineria Software formează ingineri care trebuie să demonstreze următoarele calități:

- Posedă cunoștințe și abilități ale ingineriei software, cunoaște standardele profesionale necesare pentru a începe practica inginerească;
- Demonstrează înțelegerea și poate aplica teorii, modele și tehnici care definesc fundamentele pentru identificarea, analiza, proiectarea, realizarea, implementarea, verificarea și documentarea problemelor ale domeniului obiectiv;
- Poate lucra atât de sine stătător, cât și în echipă la dezvoltarea și livrarea produselor software calitative;
- Demonstrează înțelegerea, și acordă importanță, pentru negociere, liderism și comunicare cu beneficiarii, componente indispensabile unui mediu tipic de dezvoltare software;
- Poate oferi soluții pentru diverse domenii de aplicații utilizând metode ale ingineriei software integrând aspecte etice, sociale, juridice și economice;
- Poate găsi soluții acceptabile, potrivind obiective contradictorii ale proiectului, luînd în considerare costurile, timpul, cunoștințele, dar sistemele existente.

Prin urmare drept finalități scontate ale programului de studiu 0613.3 Ingineria Software se preconizează formarea tinerilor specialiști, deținători ai titlului de inginer-licenţiat, care dau dovadă de cunoștințe, abilități și competențe transversale şi profesionale care corespund cerințelor angajatorilor, confirmate prin diploma de licență cu 240 de credite transferabile şi care asigură oportunitatea de angajare în câmpul muncii și/sau continuarea studiilor la ciclul II (studii superioare de master).

Șeful departamentului
Ingineria software și automatică,
Universitatea Tehnică a Moldovei

conf. univ. dr. Dumitru Ciorbă

Anexa 1. **Grila 1L - Descrierea domeniului/programului de studii prin competențe profesionale și transversale**

Domeniul general de studiu:	Domeniul de formare profesională:	Programului de studiu:
061 Tehnologii ale informației și comunicațiilor	*0613 Dezvoltarea produselor program și a aplicațiilor*	*0613.3 Ingineria software*

Denumirea calificării: ***Ingineria software*** Nivelul calificării: Licență	**Ocupații posibile (în conformitate cu CORM):** ***25 Specialiști în tehnologia informației și comunicațiilor*** • *251 Analiști programatori în domeniul software* (2511 Analiști de sistem, 2512 Proiectanți de software, 2513 Proiectanți de sisteme web și multimedia, 2514 Programatori de aplicații, 2519 Analiști programatori în domeniul software neclasificați în grupele de bază anterioare)

Competențe profesionale / **Descriptori de nivel ai elementelor structurale ale competențelor profesionale**	**C1** **Privind fundamentele științifice și inginerești ale tehnologiilor informaționale**	**C2** **Privind aspectele organizaționale și informaționale ale sistemelor**	**C3** **Privind tehnologiile aplicațiilor**	**C4** **Privind metodele și tehnologiile de dezvoltare software**	**C5** **Privind arhitectura și infrastructura sistemelor de calcul**
Cunoștințe					
D1 Cunoașterea, înțelegerea conceptelor, teoriilor si metodelor de baza ale domeniului si ale ariei de specializare; utilizarea lor adecvata in comunicarea profesionala	C1.1 Identificarea și definirea conceptelor, teoriilor și metodelor de ***științe fundamentale și*** *aplicative* suport pentru ingineria tehnologiilor informaționale	C2.1 Identificarea și definirea conceptelor, teoriilor și metodelor folosite în realizarea de *analize focusate pe oameni* ***și informație*** privind sistemele ce operează la nivel de organizații	C3.1 Identificarea și definirea conceptelor, procedeelor și metodelor de procesare a informației folosite în realizarea de ***aplicații ce reies din necesități*** ale activității umane	C4.1 Identificarea și definirea conceptelor și metodelor focusate pe *procesul de dezvoltare, implementare și utilizare a software*-ului	C5.1 Identificarea și definirea de componente arhitecturale hardware, software și de comunicații, precum și celor necesare la *descrierea unei infrastructuri de calcul*
D2 Utilizarea cunoștințelor de baza pentru explicarea si interpretarea unor variate tipuri de concepte, situații, procese, proiecte etc. asociate domeniului	C1.2 Explicarea soluțiilor inginerești prin utilizarea tehnicilor, conceptelor și principiilor din științele exacte și aplicative	C2.2 Explicarea conceptelor, teoriilor și metodelor folosite în realizarea de analize privind sistemele ce operează la nivel de organizații	C3.2 Explicarea tehnologiilor potrivite pentru realizarea de aplicații necesare în activitățile organizațiilor	C4.2 Explicarea conceptelor și metodelor folosite pentru dezvoltarea, implementarea și utilizarea software-ului	C5.1 Explicarea interacțiunii și funcționării componentelor arhitecturale și de infrastructură

Competențe profesionale / Descriptori de nivel ai elementelor structurale ale competențelor profesionale	C1 Privind fundamentele științifice și inginerești ale tehnologiilor informaționale	C2 Privind aspectele organizaționale și informaționale ale sistemelor	C3 Privind tehnologiile aplicațiilor	C4 Privind metodele și tehnologiile de dezvoltare software	C5 Privind arhitectura și infrastructura sistemelor de calcul
Abilități					
D3 Aplicarea unor principii și metode de bază pentru rezolvarea de probleme/situații bine definite, tipice domeniului în condiții de asistență calificată	C1.3 Rezolvarea prob-lor din domenii de activitate umană prin aplicarea în special al teluicilor și metodelor de calcul numeric	C2.3 Aplicarea conceptelor, teoriilor și metodelor de bază pentru *pregătirea informațiilor necesare elaborării* de sisteme care să opereze la nivel de organizații	C3.3 Utilizarea tehnologiilor moderne în definirea aplicațiilor software	C4.3 Aplicarea limbajelor de programare, a mediilor de modelare și dezvoltare, a metodologiilor pentru crearea de software	C5.3 Aplicarea metodelor de bază pentru specificarea de soluții arhitecturale și de infrastructură pentru probleme tipice de calcul
D4 Utilizarea adecvata de criterii și metode standard de evaluare pentru a aprecia calitatea, meritele și limitele unor procese, programe, proiecte, concepte, metode și teorii	C1.4 Alegerea criteriilor și metodelor pentru analiza avantajelor și dezavantajelor metodelor și procedeelor aplicate la soluționarea *problemelor de calcul numeric*.	C2.4 Alegerea criteriilor și metodelor de evaluare a calității, performanțelor și limitelor *sistemelor de elaborat* în corespundere cu necesitățile organizației de studiu, inclusiv celor necesare pentru definirea unui sistem de management al calității și securității	C3.4 Utilizarea de criterii și metode determinate de tehnologiile aplicațiilor pentru evaluarea conformității cu standardele de interoperabilitate	C4.4 Utilizarea de criterii și metode de evaluare a *procesului de elaborare* a sistemelor din punct de vedere a calității și performanțelor	C5.4 Utilizarea de criterii și metode de *evaluare a caracteristicilor funcționale și nefuncționale ale componentelor* de sistem
D5 Elaborarea de proiecte profesionale cu utilizarea unor principii și metode consacrate în domeniu	C1.5 Modelarea unor probleme tip din științele aplicative folosind aparatul matematic	C2.5 Elaborarea unui proiect (specificație de sistem) în condițiile existenței unui sistem de management al calității și securității.	C3.5 Dezvoltarea de aplicații software utilizând tehnologii moderne de transmitere, stocare și procesare date în corespundere cu necesitățile unei organizații	C4.5 Dezvoltarea și implementarea de software pentru probleme concrete din diverse domenii ale activității umane	C5.5 Implementarea unei soluții arhitecturale și de infrastructură în baza unor constrângeri enunțate de proiect.

Competențe profesionale / Descriptori de nivel ai elementelor structurale ale competențelor profesionale	C1 Privind fundamentele științifice și inginerești ale tehnologiilor informaționale	C2 Privind aspectele organizaționale și informaționale ale sistemelor	C3 Privind tehnologiile aplicațiilor	C4 Privind metodele și tehnologiile de dezvoltare software	C5 Privind arhitectura și infrastructura sistemelor de calcul
Standarde minimale de performanta pentru evaluarea competenței	Identificarea și aplicarea metodelor și algoritmilor învățați pentru probleme tip ale științelor fundamentale și aplicative.	Analiza și modelarea unui sistem orientat pe o problemă tip organizațională și/sau informațională a unui domeniu de activitate umană.	Identificarea și utilizarea tehnologiilor necesare dezvoltării unei aplicații software.	Analiza și modelarea și realizarea unui prototip funcțional în conformitate cu procesele tehnologice de dezvoltare	Identificarea componentelor hardware, software și de comunicații destinate aplicațiilor specifice domeniului selectat

Descriptori de nivel ai elementelor structurale ale competențelor profesionale	Competențe transversale	Standarde minimale de performanta pentru evaluarea competenței
D6. Executarea responsabila a sarcinilor profesionale, în condiții de autonomie restrânsă și asistență calificata	CT1. Aplicarea principiilor, normelor și valorilor eticii profesionale	Realizarea proiectelor respectând normele deontologiei profesionale
D7. Familiarizarea cu rolurile și activitățile specifice muncii în echipă și distribuirea de sarcini pentru nivelurile subordonate	CT2. Identificarea, descrierea și derularea activităților organizate într-o echipă cu dezvoltarea capacităților de comunicare și colaborare, dar și cu asumarea diferitelor roluri (de execuție și conducere)	Realizarea unui proiect în echipa, cu asumarea responsabilă a unor roluri diferite
D8. Conștientizarea nevoii de formare continuă utilizarea eficientă a resurselor și tehnicilor de învățare pentru dezvoltarea personală și profesională	CT3. Demonstrarea spiritului de inițiativă și acțiune pentru actualizarea cunoștințelor profesionale, economice și de cultura organizațională	Elaborarea și aplicarea unui plan personal de dezvoltare personală; comunicare proiect în limba română/rusă și în limba engleză/franceză.

Anexa 2. Grila 2L – Coordonarea dintre competențele dezvoltate și unitățile de curs/module

Competențe profesionale	Competențe explicate prin descriptori de nivel	Arii de conținut	Discipline de studii	Credite	
				Pe disciplină	Pe competență
1	2	3	4	5	6
C1 Privind fundamentele științifice și inginerești ale tehnologiilor informaționale	C1.1 Identificarea și definirea conceptelor, teoriilor și metodelor de *științe fundamentale și aplicative* suport pentru ingineria tehnologiilor informaționale C1.2 Explicarea soluțiilor inginerești prin utilizarea tehnicilor, conceptelor și principiilor din științele exacte și aplicative C1.3 Rezolvarea problemelor din domenii de activitate umană prin aplicarea în special al tehnicilor și metodelor de calcul numeric C1.4 Alegerea criteriilor și metodelor pentru analiza avantajelor și dezavantajelor metodelor și procedeelor aplicate la soluționarea *problemelor de calcul numeric*. C1.5 Modelarea unor probleme tip din științele aplicative folosind aparatul matematic	Științe exacte și aplicative	Matematica	5	68
			Matematici speciale 1	5	
			Matematici speciale 2	5	
			Modele echivalente	5	
			Științe aplicate	5	
			Prelucrarea semnalelor	5	
			Dezvoltarea personală și profesională/Știința calculatoarelor și societatea	3	
			Managementul proiectelor/Managementul întreprinderii	3	
			Marketingul electronic/Antreprenoriatul digital	3	
			Criptografie și securitate	1	
		Programare	Programarea calculatoarelor	5	
			Structuri de date și algoritmi	5	
			Limbaje formale și proiectarea compilatoarelor	5	
			Calculabilitate și complexitate	5	
			Analiza și vizualizarea datelor/ Grafica pe calculator	1	
			Elaborarea limbajelor specifice domeniului	4	
			Practica și proiectarea de licență	2	
			Proba teoretică de sinteză	1	
C2 Privind aspectele organizaționale și informaționale ale sistemelor	C2.1 Identificarea și definirea conceptelor, teoriilor și metodelor folosite în realizarea de analize focusate pe oameni și informație privind sistemele ce operează la nivel de organizații C2.2 Explicarea conceptelor, teoriilor și metodelor folosite în realizarea de analize privind sistemele ce operează la nivel de organizații C2.3 Aplicarea conceptelor, teoriilor și metodelor de bază pentru pregătirea informațiilor necesare elaborării de sisteme care să opereze la nivel de organizații C2.4 Alegerea criteriilor și metodelor de evaluare a calității, performanțelor și limitelor sistemelor de	Securitatea informațională	Etică, comunicare și drept	2	17
			Dezvoltarea aplicațiilor securizate	1	
			Criptografie și securitate	1	
		Managementul informației	Managementul proiectelor/Managementul întreprinderii	1	
			Marketingul electronic/Antreprenoriatul digital	1	
		Dezvoltare software	Proiectare conceptuală a unei aplicații IT	3	
			Proiectarea sistemelor informaționale	3	
			Proba teoretică de sinteză	1	
			Practica și proiectarea de licență	2	

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1	2	3	4	5	6
	elaborat în corespundere cu necesitățile organizației de studiu, inclusiv celor necesare pentru definirea unui sistem de management al calității și securității C2.5 Elaborarea unui proiect (specificație de sistem) în condițiile existenței unui sistem de management al calității și securității.				
		Calitatea software	Calitatea software-ului/Analiza și specificarea cerințelor software	2	
C3 Privind tehnologiile aplicațiilor	C3.1 Identificarea și definirea conceptelor, procedeelor și metodelor de procesare a informației folosite în realizarea de *aplicații ce reies din necesități* ale activității umane C3.2 Explicarea tehnologiilor potrivite pentru realizarea de aplicații necesare în activitățile organizațiilor C3.3 Utilizarea tehnologiilor moderne în definirea aplicațiilor software C3.4 Utilizarea de criterii și metode determinate de tehnologiile aplicațiilor pentru evaluarea conformității cu standardele de interoperabilitate C3.5 Dezvoltarea de aplicații software utilizând tehnologii moderne de transmitere, stocare și procesare date în corespundere cu necesitățile unei organizații	Arhitecturi, platforme și tehnologii	Tehnologii multimedia/Tehnici de simulare și modelare	3	**52**
			Dezvoltarea personală și profesională/Știința calculatoarelor și societatea	1	
			Proiecte IoT	2	
			Sisteme încorporate	3	
			Programarea aplicațiilor mobile/Programarea web	1	
		Managementul informației	Baze de date	5	
			Proiectare conceptuală a unei aplicații IT	2	
			Fundamente ale inteligenței artificiale/Baze de date nerelaționale	2	
		Programare	Bazele dezvoltării aplicațiilor	4	
			Dezvoltarea aplicațiilor securizate	4	
			Modele echivalente	2	
			Elaborarea limbajelor specifice domeniului	2	
			Programarea în rețea	2	
			Programarea orientată pe obiecte	2	
			Proiectarea sistemelor informaționale	3	
			Programarea aplicațiilor distribuite	2	
			Analiza și vizualizarea datelor/ Grafica pe calculator	2	
			Tehnici și mecanisme de proiectare software Verificarea și validarea produselor program	2	
			Programarea aplicațiilor mobile/Programarea web	2	
			Fundamente ale dezvoltării jocurilor/ Tehnologii de realitate mixtă	2	
			Practica și proiectarea de licență	3	
			Proba teoretică de sinteză	1	
C4 Privind metodele și tehnologiile de dezvoltare software	C4.1 Identificarea și definirea conceptelor și metodelor focusate pe *procesul de dezvoltare, implementare și utilizare a software*-ului	Programare	Programarea orientată pe obiecte	3	**54**
			Programarea în rețea	2	
			Proiecte IoT	4	
			Sisteme încorporate	2	
			Programarea aplicațiilor distribuite	2	

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1	2	3	4	5	6
	C4.2 Explicarea conceptelor și metodelor folosite pentru dezvoltarea, implementarea și utilizarea software-ului C4.3 Aplicarea limbajelor de programare, a mediilor de modelare și dezvoltare, a metodologiilor pentru crearea de software C4.4 Utilizarea de criterii și metode de evaluare a *procesului de elaborare* a sistemelor din punct de vedere a calității și performanțelor C4.5 Dezvoltarea și implementarea de software pentru probleme concrete din diverse domenii ale activității umane		Analiza și vizualizarea datelor/ Grafica pe calculator	2	
			Tehnologii multimedia/Tehnici de simulare și modelare	2	
			Interacțiunea om-calculator/ Programarea în timp real	3	
			Programarea aplicațiilor mobile/Programarea web	1	
		Dezvoltare software	Bazele dezvoltării aplicațiilor	4	
			Dezvoltarea aplicațiilor securizate	3	
			Elaborarea limbajelor specifice domeniului	2	
			Proiectare conceptuală a unei aplicații IT	2	
			Criptografie și securitate	3	
			Proiectarea sistemelor informaționale	2	
			Fundamente ale inteligenței artificiale/Baze de date nerelaționale	3	
			Fundamente ale dezvoltării jocurilor/Tehnologii de realitate mixtă	3	
			Proba teoretică de sinteză	1	
			Practica și proiectarea de licență	3	
			Susținerea proiectului de licență	1	
		Calitatea software	Tehnici și mecanisme de proiectare software Verificarea și validarea produselor program	3	
			Calitatea software-ului/Analiza și specificarea cerințelor software	3	
C5 Privind arhitectura și infrastructura sistemelor de calcul	C5.1 Identificarea și definirea de componente arhitecturale hardware, software și de comunicații, precum și celor necesare la *descrierea unei infrastructuri de calcul* C5.1 Explicarea interacțiunii și funcționării componentelor arhitecturale și de infrastructură C5.3 Aplicarea metodelor de bază pentru specificarea de soluții arhitecturale și de infrastructură pentru probleme tipice de calcul C5.4 Utilizarea de criterii și metode de *evaluare a caracteristicilor funcționale și nefuncționale ale componentelor* de sistem C5.5 Implementarea unei soluții arhitecturale și de infrastructură în baza unor constrângeri enunțate	Programare	Programarea aplicațiilor distribuite	1	**24**
			Programarea aplicațiilor mobile/Programarea web	1	
			Programarea în rețea	1	
			Practica și proiectarea de licență	2	
		Rețele și comunicații de date	Rețele de calculatoare	5	
			Proiecte IoT	2	
		Arhitecturi, platforme și tehnologii	Arhitectura calculatoarelor	5	
			Sisteme de operare: mecanisme interne și principii de proiectare	5	
			Interacțiunea om-calculator/ Programarea în timp real	2	

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Competențe transversale	Discipline de studii	Credite	
		Pe disciplină	Pe competență
CT1. Aplicarea principiilor, normelor și valorilor eticii profesionale	Etică, comunicare și drept	3	8
	Proiectare conceptuală a unei aplicații IT	1	
	Dezvoltarea personală și profesională/Știința calculatoarelor și societatea	1	
	Managementul proiectelor/Managementul întreprinderii	1	
	Marketingul electronic/Antreprenoriatul digital	1	
	Practica și proiectarea de licență	1	
CT2. Identificarea, descrierea și derularea activităților organizate într-o echipă cu dezvoltarea capacităților de comunicare și colaborare, dar și cu asumarea diferitelor roluri (de execuție și conducere)	Modele echivalente	2	9
	Elaborarea limbajelor specifice domeniului	1	
	Proiectare conceptuală a unei aplicații IT	1	
	Bazele dezvoltării aplicațiilor	1	
	Dezvoltarea aplicațiilor securizate	1	
	Proiecte IoT	1	
	Proiectarea sistemelor informaționale	1	
	Practica și proiectarea de licență	1	
CT3. Demonstrarea spiritului de inițiativă și acțiune pentru actualizarea propriilor cunoștințe profesionale, economice și de cultura organizațională	Modele echivalente	1	8
	Elaborarea limbajelor specifice domeniului	1	
	Proiectare conceptuală a unei aplicații IT	1	
	Bazele dezvoltării aplicațiilor	1	
	Dezvoltarea aplicațiilor securizate	1	
	Proiecte IoT	1	
	Proiectarea sistemelor informaționale	1	
	Practica și proiectarea de licență	1	
Total program de studiu			**240**

Annex 3: Bachelor`s Degree Programme on Softaware Engineering English Translation

Ministry of Education of the Republic of Moldova
Technical University of Moldova
Faculty of Computers, Informatics and Microelectronics

APPROVED
at the Senate Meeting of
Technical University of Moldova
Minutes No. 4
of 27 December 2016
Chairperson of Senate
Rector, PhD _____ (stamp)
Viorel BOSTAN

COORDINATED
Ministry of Education of the
Republic of Moldova
24 July 2017
Registration No. ISL-01-18130
(stamp)

CURRICULUM

Cycle I, Licentiate/Bachelor's Degree (Level 6 according to ISCED)

General field of study:	*061 Information and Communication Technologies*
Field of professional study:	0613 Software and Application Development
Specialty/ Major:	0613.1 Software Engineering
Total number of credits:	240
Degree obtained upon the completion of studies:	Licentiate Engineer/Bachelor's Degree
Certification:	Licentiate Diploma
Basis for Admission:	High school diploma or an equivalent education document; higher education diploma
Language of instruction:	Romanian, Russian, English
Form of education:	Full-time attendance

1. ACADEMIC CALENDAR

Academic year	Teaching activities		Examination period		Internships	Vacations		
	Semester I	Semester II	Semester I	Semester II		winter	spring	summer
I	**15 weeks**	**15 weeks**	**4 weeks**	**4 weeks**	-	***2* weeks**	**Vacation on Easter – one week (according to the Christian calendar)**	**10 weeks**
II	**15 weeks**	**15 weeks**	**4 weeks**	**4 weeks**	**15 weeks**	2 **weeks**		**6 weeks**
III	**15 weeks**	**15 weeks**	**4 weeks**	**4 weeks**	**15 weeks**	2 **weeks**		**6 weeks**
IV	**15 weeks**	7 ***weeks***	**4 weeks**	2 **weeks**	**10 weeks**	2 **weeks**		**9 weeks**

2. Curriculum by semesters/academic years

Year I

Semester I. *Problem Based Learning in Science, Technology and Society*

Code	Name of the Course Unit/Module	Total number of hours			Number of hours by types of activity				Type of final assessment	Number of credits e
		total	direct instruction	individual work	C	S/P	Pr	per week		
G.01.O.013	Conceptual Design of an IT Application	300	150	150			150		PA	10
F.01.O.001	Math	150	75	75	45	30			E	5
F.01.O.002	Computer Programming	150	75	75	30	15	30		E	5
F.01.O.003	Special Math 1	150	75	75	30	45			E	5
U.01.A.021 *U.01.A.022*	Personal and Professional Development *Computer Science and Society*	150	75	75	30	30	15		E	5
GM.O.014	*Foreign Language 1***	*90*	*45*	*45*		*45*			*E**	*3*
G.01.O.015	*Romanian (for non-speakers of Romanian) 1 **	*60*	*30*	*30*		*30*			*T**	*2*
G.01.O.016	*Physical training 1 **	*60*	*30*	*30*		*30*			*T**	
Total per Semester I:		900	450	450	135	120	195	0	4E, 1PA	30
					*4*50					

Semester II. *Engineering and Scientific Bases for Computing*

Code	Name of the Course Unit/Module	Total number of hours			Number of hours by types of activity				Type of final assessment	Number of credits e
		total	direct instruction	individual work	C	S/P	Pr	per week		
F.02.O.004	Equivalent Models	300	150	150			150		PA	10
F.02.O.005	Applied Science	150	75	75	30	15	30		E	5
F.02.O.006	Special Math 2	150	75	75	30	15	30		E	5
F.02.O.007	Computer Architecture	150	75	75	30	45			E	5
F.02.O.008	Data Structures and Algorithms	150	75	75	30	30	15		E	5
G.02.O.017	*Foreign Language 2**	*90*	*45*	*45*		*45*			*E**	*3*
G.02.O.018	*Romanian (for non-speakers of Romanian) 2**	*60*	*30*	*30*		*30*			*T**	*2*
G.02.O.019	*Physical training 2**	*60*	*30*	*30*		*30*			*T**	
	Total per Semester II:	900	450	450	120	105	225	0	4E, 1PA	30
					*4*50					
Total per Year I:		1800	900	900	255	225	420	0	8E, 2PA	60

**** - This is not included in the total sum of evaluation forms (the course units are provided in extracurricular regime, and those 240 credits per program are supplement with additional credits, while the course unit "Physical training" is not quantified with credits).***

Year II

Semester III. *Application Development Bases*

Code	Name of the Course Unit/Module	Total number of hours			Number of hours by types of activity				Type of final assessment	Number of credits e
		total	direct instruction	individual work	C	S/P	Pr	per week		
S.03.O.027	*Application Development Basics*	300	150	150			150		PA	10
S.03.O.028	Object Oriented Programming	150	75	75	30	15	30		E	5
S.03.O.029	Computer Networks	150	75	75	30	45			E	5
S.03.O.030	Databases	150	75	75	30	15	30		E	5
S.03.A.039 *S.03.A.040*	Data Analysis and View; *Computer Graphics*	150	75	75	30	30	15		E	5
Total per Semester III:		900	450	450	120	105	225	0	4E, 1PA	30
					450					

Semester IV. *Formal Languages and Compilers*

Code	Name of the Course Unit/Module	Total number of hours			Number of hours by types of activity				Type of final assessment	Number of credits e
		total	direct instruction	individual work	C	S/P	Pr	per week		
F.04.O.009	Developing Industry Specific Languages	300	150	150			150		PA	10
F.04.O.010	Formal Languages and Compiler Design	150	75	75	30	15	30		E	.. 5
F.04.O.011	Calculability and Complexity	150	75	75	30	15	30		E	5
S.04.O.031	Operating Systems: Internal Mechanisms and Design Principles	150	75	75	30	45			E	5
S.04.A.041 *S.04.A.042*	Multimedia Technologies *Simulation and Modelling Techniques*	150	75	75	30	30	15		E	5
Total per Semester IV:		900	450	450	120	105	225	0	4E, 1PA	30
					450					
Internship in Production (It shall be carried out at the Student's choice on the basis of Modules *Application Development Basics and Developing Industry Specific Languages)*										
Total per Year II:		1800	900	900	240	210	450	0	8E, 2PA	60

Year III

Semester V. *Network and Security*

Code	Name of the Course Unit/Module	Total number of hours			Number of hours by types of activity				Type of final assessment	Number of credits e
		total	direct instruction	individual work	C	S/P	Pr	per week		
S.05.O.032	**Developing Secure Applications**	**300**	**150**	**150**			**150**		**PA**	**10**
S.05.O.033	**Network Programming**	**150**	**75**	**75**	**30**	**15**	**30**		**E**	**5**
S.05.O.034	**Cryptography and Security**	**150**	**75**	**75**	**30**	**15**	**30**		**E**	**5**
G.05.O.020	**Ethics, Communication and Law**	**150**	**75**	**75**	**45**	**30**			**E**	**5**
S.05.A.043 ***S.05.A.044***	**Software Design Techniques and Mechanisms** ***Software Verification and Validation***	**150**	**75**	**75**	**30**	**30**	**15**		**E**	**5**
Total per Semester V:		**900**	**450**	**450**	**135**	**90**	**225**	**0**	**4E, 1PA**	**30**
					***4*50**					

Semester VI. *Internet of Things (IoT)*

Code	Name of the Course Unit/Module	Total number of hours			Number of hours by types of activity				Type of final assessment	Number of credits e
		total	direct instruction	individual work	C	S/P	Pr	per week		
S.06.O.035	**IoT Projects**	**300**	**150**	**150**			**150**		**PA**	**10**
S.06.O.036	**Embedded Systems**	**150**	**75**	**75**	**30**	**15**	**30**		**E**	**5**
F.06.O.012	**Signal Processing**	**150**	**75**	**75**	**30**	**30**	**15**		**E**	**5**
S.06.A.045 ***S.06.A.046***	**Human-Computer Interaction** ***Real Time Programming***	**150**	**75**	**75**	**30**	**15**	**30**		**E**	**5**
S.06.A.047 ***S.06.A.048***	**Mobile Application Development** ***WEB Programming***	**150**	**75**	**75**	**30**	**15**	**30**		**E**	**5**
Total per Semester VI:		**900**	**450**	**450**	**120**	**75**	**255**	**0**	**4E, 1PA**	**30**
					***4*50**					
Technological Internship (It shall be carried out at the Student's choice on the basis of Modules *Developing Secure Applications and IoT Projects)*										
Total per Year III:		**1800**	**900**	**900**	**255**	**165**	**480**	**0**	**8E, 2PA**	**60**

Year *IV*

Semester VII. *Information Systems*

Code	Name of the Course Unit/Module	Total number of hours			Number of hours by types of activity				Type of final assessment	Number of credits e
		total	direct instruction	individual work	C	S/P	Pr	per week		
S.07.O.037	Information System Design	300	150	150			150		PA	10
S.07.O.038	Programming of Distributed Applications	150	75	75	30	15	30		E	5
U.07.A.023 *U.07.A.024*	Software Project Management *Enterprise Management*	150	75	75	30	30	15		E	5
U.07.A.025 *U.07.A.026*	Electronic Marketing *Digital Entrepreneurship*	150	75	75	30	30	15		E	5
S.07.A.049 *S.07.A.050*	Software Quality *Analysis and Specification of Software Requirements*	150	75	75	30	30	15		E	5
Total per Semester VII:		900	450	450	120	105	225	0	4E, 1PA	30
					450					

Semester VIII. *Licentiate Project*

Code	Name of the Course Unit/Module	Total number of hours			Number of hours by types of activity				Type of final assessment	Number of credits e
		total	direct instruction	individual work	C	S/P	Pr	per week		
S.Q8.A.051 *S.V8.A.052*	Foundations of Artificial Intelligence *Non-relational Databases*	150	75	75	30	45			E	5
S.08.A.053 *S.08.A.054*	Foundations for Game Development *Technologies of Mixed Reality*	150	75	75	30	45			E	5
S.08.O.055	Licentiate Internship and Design	450		450					E	15
S.08.O.056	Summary Theory Exam: *Algorithms, Programming and Databases*	120		120					E	4
S.08.O.057	Defending the Licentiate Project	30		30					E	1
Total per Semester VIII:		900	150	750	60	90	0	0	5E	30
Total per Year IV:		1800	600	1200	180	195	225	0	9E, 1PA	60
Total for the Study Programme:		7200	3300	3900	930	795	1575	0	33E, 7PA	240

3. Internships

Internships*		Semester	Duration, number of weeks/hours	Period	Number of credits
1	Internship in Production	3/4	15	September - December/ February - May	10
2	Technological Internship	5/6	15		10
3	Licentiate Internship and Design	8	10	March - May	15
Total:			24/990		35

**** Internships shall be carried out on the basis of a Semestrial Design Module.***

4. Free choice (optional) course units

Criterion #	Name	Year	Sem.	Number of hours by types of activity per week			Type of final assessment	Number of credits
				C	S/P	L		
1	Introduction into the Specialty	l	2	30			E	2
2	Psychology of Invention	2	4	30			E	2
3	Cognitive Philosophy	2	4	30			E	2
4	Graphical Representation of Data	3	5	30		30	E	4
5	Programming in Virtual Reality	3	5	30		30	E	4
6	Techniques for Reverse Engineering	3	6	30		30	E	4
7	Managerial Psychology	3	6	30			E	2
8	E-Governance	4	7	30			E	2
9	Romanian (for non-speakers of Romanian) 3	2	3		30		E	2
10	Romanian (for non-speakers of Romanian) 4	2	4		30		E	2
11	Romanian (for non-speakers of Romanian) 5	3	5		30		E	2
12	Romanian (for non-speakers of Romanian) 6	3	6		30		E	2
13	Foreign Language 3	2	3		30		E	2
14	Foreign Language 4	2	4		30		E	2
15	Foreign Language 5	3	5		30		E	2
16	Foreign Language 6	3	6		30		E	2
17	Foreign Language 7	4	7		30		E	2
18	Physical training 3	2	3		30		T*	
19	Physical training 4	2	4		30		T*	
20	Physical training 5	3	5		30		T*	
21	Physical training 6	3	6		30		T*	
22	Physical training 7	4	7		30		T*	

5. Licentiate Exam

Criterion #	Name of activity	Period	Number of credits
1	**Summary Theory Exam:** ***Algorithms, Programming and Databases***	**29.02. - 12.03**	**4**
2	**Defending the Licentiate Project**	**06.06. - 25.06**	**1**
Total:			**5**

Approved at the TUM Senate meeting, Minutes No. 4 of 27.12.2016.

Ion BALMUS	**Dean of CIM Faculty, Dr., Associate Professor**
Dumitru CIORBA	**Head of Department of Software Engineering and Automatics, Dr., Associate Professor**

MINISTERUL EDUCAȚIEI
AL REPUBLICII MOLDOVA
UNIVERSITATEA TEHNICĂ
A MOLDOVEI

MINISTRY OF EDUCATION
OF THE REPUBLIC OF MOLDOVA
TECHNICAL UNIVERSITY
OF MOLDOVA

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FACULTY OF COMPUTERS, INFORMAICTS AND MICROELECTRONICS

DEPARTMENT OF SOFTWARE ENGINEERING AND AUTOMATICS

Curriculum for Licentiate Course 0613.3 Software Engineering

Chisinau 2016

EXPLANATORY NOTE
to the Curriculum for Licentiate Studies (Cycle I)

Fundamental Area of Science, Culture and Technique: *06 Information and Communication Technologies*

General Area of Study: *061 Information and Communication Technologies*

Area of Professional Education: *0613 Software and Application Development*

Programme of Study: *0613.3 Software Engineering*

Description of Software Engineering Specialty Profile

Software Engineering (SE), along with *Information Technology,* falls within the *Computer Science area,* which pursues the goal to address certain issues related to organising human activities. Relative to Information Technology, *Software Engineering* has got a more theoretical approach focused on training professionals whose essential mission is to develop models and techniques for software production, which scope covers systems infrastructure, as well as organisation and information aspects of enterprises.

This theoretical aspect of Software Engineering stems from the fact that the studied software development procedures have a theoretical sublayer, which is better founded under the Software Engineering Study Programme.

At the same time, the *Software Engineering* Study Programme covers procedures for using the information with the specific aim to design, build and use IT products and services, thus, having established common areas with the Information Technology Programme.

Description of professional training in Software Engineering

Since the beginning of electronic computing in the 40s of the past Century, the computing systems and all the sectors involving them have showed an ever-growing utilization rate. Nowadays, software already defines the essential elements of human activity: governance, communications, production, banks and finances, education, transportation, entertainment, healthcare, agriculture and law. Software products help the world be more efficient and more productive. The OECD data show huge amounts of money spent on software development. Despite such successes, there are serious challenges in terms of development costs, timeliness and quality of many software products. The ACM curricular Guidelines mentions several reasons explaining these challenges, which are definitional for the emergence of a new programme:

- Software products are among the most complex man-made systems, and by its nature, software has got intrinsic, essential properties, which cannot be easily tackled;
- The programming techniques that work well in small teams and for developing moderate products may be not suitable for producing large and complex systems;
- The pace of changes in the area of information and communication technologies (ICT) leads towards new and more advanced/sophisticated products. Therefore, the expectations of beneficiaries and other driving forces put pressure on quality and timeliness of developed products;

- The availability of highly qualified software engineers has not kept pace with the industry demand; therefore, pretty frequently the systems are designed and built by people who lack appropriate training or experience.

The relevance of the new Study Programme is underpinned also by the data of the USAID Survey *(Updating the IT skills gap* - O'Sullivan and Bercu, 2016), which revealed the stringent need for even more professionals in the area of software development.

The high pace of globalization has been largely due to information technologies, which provide opportunities for exploiting the information. The acknowledgment of this fact has been embodied in diverse national and international acts:

- Digital Agenda for *Europe 2020* is part of those seven remarkable initiatives of the European Strategy for Sustainable and Comprehensive Development and is aimed at bringing major economic and social benefits to be generated by a digital single market, which by the middle of its implementation term shall provide the following: a) 50% of population buying online; b) 33% of small and medium-sized enterprises selling online; c) 50% of citizens benefiting from e-Governance services; d) most public services being accessible online in all EU-member countries, etc.
- Transformation of the Republic of Moldova in a modern and effective country is possible only through *technological modernisation* at the level of society, organisations and individuals *(actions that are envisaged also in the Strategic Programme for Technological Modernisation of Governance).*

Therefore, ***the primary goal pursued by the Study Programme*** *is determined by the demand for highly trained engineers in compliance with the area of professional training, who are able to offer advanced software solutions and innovations applied in diverse areas of human activity.*

The Technical University of Moldova (TUM), through its Department on Software Engineering and Automatics, is the *first University that* has trained licentiate engineers in Information Technologies for the national economy *since* 1993. However, the consultations held with its partners (public organisations, private companies and students) have revealed the need for new approaches: *team work and interdisciplinarity.*

As consultations are carried out on a continuous basis, collaboration events are conducted through different workshops and inter-institutional projects involving the Department staff. Among the private companies engaged in the process of consultation or support partnership we can mention Orange, StarNet, Allied Testing, Endava, Pentalog, JMD Planet, Winify, Evisoft, TenerLab, Dekart, etc.

Ensuring Quality Education

The quality of educational activities is a permanent priority of the Department of Software Engineering and Automatics as the unit delivers many study programmes: *Information Technologies, Information Security,* as well as *Automatics and Informatics.* The quality evaluation process comprises a multi-criteria approach, which considers the study results expressed in *knowledge, skills and competences.* The approach components cover the following aspects:

- compliance with the Higher Education Framework Plan *(approved by the Ministry of Education Order No. 1045 of 29 October 2015);*
- compliance with referenced standards *(Software Engineering 2014/ Curriculum Guidelines for Undergraduate Degree Programs in Software Engineering, Association for Computing Machinery (ACM), IEEE Computer Society),*
- in terms of the content and structure of the subjects taught – their topicality, integration of research outcomes, developing the skills on how to apply the knowledge in new situations;

Providing with Teaching Staff

Our teaching staff managed to take part in many scientific and didactic activities embedded in *institutional, national and international projects, by* collaborating lately with researchers of similar institutions from Romania, Russia, Denmark, Germany, France, Great Britain, Sweden, Israel, etc. The multidisciplinary feature of this area includes the works of many researchers with academic degrees who have been involved in the study programme:

Total course units/modules	Number of Course Holders with the functions of			
	University Professors	Associate Professors	University Lecturers	University Assistants
54	2	11	6 + 1 (with academic degree)	-

Competences developed by the Study Programme and coordination between them and the course units/modules

Professional competences developed by the Study Programme are determined by the definition of Software Engineering Specialty in compliance with the *ACM Standard – Association for Computing Machinery and IEEE Computer Society, involving a mixture of skills aimed at addressing certain categories of issues outlined through key competences related to*:

- scientific and engineering foundations of information technologies;
- organisation and information aspects of systems;
- application technologies;
- software development methods and technologies;
- architecture and infrastructure of computing systems.

The professional and crosscutting competences are covered by fundamental, general, socio-humanistic and specialty subjects, which shares have been set in compliance with the Framework Plan. Further specification of competences developed, as well as their distribution by the content areas is displayed in the matrixes presented in Annexes 1 and 2.

Graduates' Employability

Taking account of the growing need in qualified professionals on the national and regional markets, the TUM graduates have shown a high rate of employability, which is proved also by the USAID Survey. The Classifier of Occupations in the Republic of Moldova, approved by the Government of the RM on 03.03.2014, through the major subgroup *25 Professionals in Information and Communication Technology with the minor group 251 Software Programmers Analysts* (2511 System Analysts, 2512 Software Designers, 2513 Designers of WEB Systems and Multimedia, 2514

Programmers of Applications, 2519 Software Programmers Analysts not assigned to any of the previous main groups) covers the basic functions/professions of the Software Engineering Programme graduates.

Taking into account the competences acquired following the completion of the *Software Engineer* Programme, the graduates may hold positions other than those mentioned above: from teachers and researchers to director and managers of different levels.

Possibilities for *Subsequent Education*

Through the stated competences to be attained by the graduates, the Software Engineering Study Programme enables the latter to continue their university studies (Cycle II, Master's Degree) in the ICT area in any local or foreign university within the existing national and international partnerships.

Methods and criteria for competence evaluation

The minimum standards for competence evaluation are displayed in Matrix 1L (Annex 1), the essential evaluation methods comprising: papers/essays, laboratory works intended to develop engineering skills, projects with individual or team tasks with practical completion, tests/exams, licentiate exams and licentiate thesis.

The criteria for competence evaluation, in compliance with the Regulation for organizing the higher education studies on the basis of the National Credit System (the Ministry of Education Order No.726 of 20.09.2010), have been defined through the TUM regulatory acts. Hence, the Regulation for organizing the evaluation of students' learning activity (Order issued by the TUM Rector, entered in force during the 2011/2012 academic year), paragraph *2.3 Evaluation Criteria,* describes in great details the general and specific evaluation criteria (to be supplemented by attitudinal and motivation aspects).

Rules for academic promotion

Promotion to the next year level is conditioned by the accumulation of the mandatory number of credits throughout the academic year foreseen by the Study Plan. It is possible to acquire the allocated credits only when students have been evaluated with marks ranging from "5" to "10", as per the grading scale outlined in the Regulation for organizing the evaluation of students' learning activity.

To be awarded the Licentiate Diploma, students shall fulfil the Study Plan and pass the evaluation tests/exams (including the licentiate exams) and defend their licentiate project/thesis with the mark "5" at least.

Foreseen Study Objectives

The Software Engineering Study Programme is aimed at training engineers who shall be able to demonstrate the following qualities:

- Have knowledge and skills in software engineering, be familiar with professional standards required to start the engineering practical activity;
- Demonstrate the understanding and ability to apply theories, models and techniques, which define the foundations for identifying, analyzing, designing, building, implementing, verifying and documenting objectively the industry issues;

- Be able to work both independently and in teams with the aim to develop and deliver high quality software products;
- Demonstrate understanding and pay attention to leadership and communication abilities for negotiations with beneficiaries, which are indispensible components of a typical environment for software development;
- Be able to offer solutions for different areas of application, using software engineering methods and integrating ethic, social, legal and economic aspects;
- Be able to find acceptable solutions, matching the project contradictory objectives, taking into account the existing costs, time, knowledge and systems.

Hence, the Study Programme 0613.3 Software Engineering pursues the following objectives: to train professionals – holders of Licentiate Engineer' degree, who are able to demonstrate knowledge, skills and crosscutting and professional competences that meet the employers' requirements, corroborated by the Licentiate Diploma comprising 240 transferable credits and ensuring their employability and/or continuation of Cycle II (Master's Degree) studies.

Head of Department of Software Engineering and Automatics, Technical University of Moldova

Associate Professor, Dr. Dumitru CIORBA

Annex 4. Matrix 1L – Description of the Study field/Programme via professional and crosscutting competences.

General Area of Study:	Area of Professional Education:	Study Programme:
061 Information and Communication Technologies	*0613 Development of Software and Applications*	*0613.3 Software Engineering*

Qualification: ***Software Engineering***	**Possible occupations (in compliance with the Classifier of Occupations in the RM):** ***25 Professionals in Information and Communication Technology***
Level of qualification: Licentiate/Bachelor's Degree	• *251 Software Programmers Analysts* (2511 System Analysts, 2512 Software Designers, 2513 Designers of WEB Systems and Multimedia, 2514 Programmers of Applications, 2519 Software Programmers Analysts not assigned to any of the previous main groups).

Professional Competences / **Level Descriptors of structural elements of professional competences**	**C1 Scientific and engineering foundation of information technologies**	**C2 Systems organisation and information aspects**	**C3 Application technologies**	**C4 Software development methods and technologies**	**C5 Computing systems architecture and infrastructure**
Knowledge					
D1 Knowledge, understanding the basic industry and specialty concepts, theories and methods; their appropriate use during the professional communication.	C1.1 Identifying and defining *fundamental scientific and applied* concepts, theories and methods supporting the information technology engineering.	C2.1 Identifying and defining concepts, theories and methods used to conduct *human and information focused analyses* on systems operated at the level of organisations.	C3.1 Identifying and defining concepts, procedures and methods for information processing used in *application development depending on the human activity needs.*	C4.1 Identifying and defining concepts and methods focused on *software development, implementation and utilization process.*	C5.1 Identifying and defining hardware, software and communication architecture components, as well as those required for *the description of a computing infrastructure.*
D2 Using the basic knowledge for explaining and interpreting various types of concepts, situations, processes, projects, etc. associated with the industry.	C1.2 Explaining engineering solutions by using techniques, concepts and principles from pure and applied science.	C2.2 Explaining concepts, theories and methods used to conduct analyses of systems operated at the level of organisations.	C3.2 Explaining technologies appropriate for developing applications required for the organizations activities.	C4.2 Explaining concepts and methods used for software development, implementation and use.	C5.1 Explaining the interaction and functioning of architecture and infrastructure components.
Skills					

D3 Applying certain basic principles and methods to address well defined issues/situations, specific for the field under qualified assistance conditions.	C1.3 Addressing the issues related to human activity by applying, in particular, numerical computation techniques and methods.	C2.3 Applying basic concepts, theories and methods to *prepare the information necessary* to develop systems operated at the level of organisations.	C3.3 Using modern technologies to define software applications.	C4.3 Applying programming languages, modelling and development environment, methodologies to produce software.	C5.3 Applying basic methods to specify architecture and infrastructure solutions for typical computing issues.
D4 Appropriate use of standard evaluation criteria and methods to assess the quality, performance and limits/constraints of certain processes, programmes, projects, concepts, methods and theories.	C1.4 Selecting criteria and methods for analysing the advantages and disadvantages of methods and procedures applied in resolving *typical computing issues.*	C2.4 Selecting criteria and methods to assess the quality, performance and limits/constraints of *systems to be developed in compliance with the needs of the organisation subject to study*, including those necessary for defining a quality and security management system.	C3.4 Using criteria and methods determined by the application technologies to assess compliance with interoperability standards.	C4.4 Using criteria and methods to assess the *system development process in terms of its quality and performance*.	C5.4 Using criteria and methods to *assess the functional and non-functional features of system components*.
D5 Devising professional projects using proven industry related principles and methods.	C1.5 Modelling certain standard issues from applied science using math tools.	C2.5 Devising a project (system specification) under the conditions of having a quality and security management system in place.	C3.5 Developing software applications using advanced technologies to convey, store and process data in compliance with the organisation needs.	C4.5 Developing and implementing software for specific problems from diverse areas of human activity.	C5.5 Implementing architecture and infrastructure solutions based on constraints defined by the project.
Minimum Performance Standards for Competence Evaluation.	Identifying and applying methods and algorithms learned for standard issues of pure and applied science.	Analysing and modelling a system focused on standard organisation and/or information issues in an area of human activity.	Identifying and using technologies necessary for developing software applications.	Analysing, modelling and devising a functional prototype in compliance with the technological development processes.	Identifying hardware, software and communication components intended for the applications specific for a selected area.

Level descriptors for structural elements of professional competences	**Crosscutting Competences**	**Minimum Performance Standards for Competence Evaluation**
D6. Carrying out professional tasks with due diligence under limited	CT1. Applying principles, rules and values of professional ethics	Carrying out projects, having complied with the rules of professional deontology.

autonomy and qualified support.		
D7. Getting acquainted with team work specific roles and activities and assigning the tasks to subordinated levels.	CT2. Identifying, describing and unrolling the team activities aimed to develop communication and collaboration skills and to undertake different roles (executive and management roles).	Carrying out team projects, having undertaken different roles.
D8. Acknowledging the need for continuous education; efficient use of resources and learning techniques for personal and professional development	CT3. Demonstrating the spirit of initiative and action for refreshing the professional, economic and organizational culture knowledge.	Devising and applying an individual plan for personal development; communication project in Romanian/Russian and English/French.

Annex 5. Matrix 2L – Coordination between the acquired competences and the course units/module.

Professional Competences	Competences Explained by Level Descriptors	Content Areas	Subjects of Study	Credits	
				per subject	per competence
1	2	3	4	5	6
C1 **Scientific and engineering foundation of information technologies**	C1.1 Identifying and defining *fundamental scientific and applied* concepts, theories and methods supporting the information technology engineering. C1.2 Explaining engineering solutions by using techniques, concepts and principles from pure and applied science. C1.3 Addressing the issues related to human activity by applying, in particular, numerical computation techniques and methods. C1.4 Selecting criteria and methods for analysing the advantages and disadvantages of methods and procedures applied in resolving *typical computing issues.* C1.5 Modelling certain standard issues from applied science using math tools.	Pure and Applied Science	Math	5	**68**
			Special Math 1	5	
			Special Math 2	5	
			Equivalent Models	5	
			Applied Science	5	
			Signal Processing	5	
			Personal and Professional Development/Computer Science and Society	3	
			Project Management/Enterprise Management	3	
			Electronic Marketing/Digital Entrepreneurship	3	
			Cryptography and Security	1	
		Programming	Computer Programming	5	

			Data Structures and Algorithms	5	
			Formal Languages and Compiler Design	5	
			Calculability and Complexity	5	
			Data Analysis and View/ Computer Graphics	1	
			Developing Industry Specific Languages	4	
			Licentiate Internship and Design	2	
			Summary Theory Exam	1	
C2 **Systems organisation and information aspects**	C2.1 Identifying and defining concepts, theories and methods used to conduct *human and information focused analyses* on systems operated at the level of organisations. C2.2 Explaining concepts, theories and methods used to conduct analyses of systems operated at the level of organisations. C2.3 Applying basic concepts, theories and methods to *prepare the information necessary* to develop systems operated at the level of organisations. C2.4 Selecting criteria and methods to assess the quality, performance and limits/constraints of *systems to be developed in compliance with the needs of the organisation subject to study*, including those necessary for defining a quality and security management system. C2.5 Devising a project (system specification) under the conditions of having a quality and security management system in place.	Information Security	Ethics, Communication and Law	2	**17**
			Developing Secure Applications	1	
			Cryptography and Security	1	
		Information Management	Project Management/Enterprise Management	1	

			Electronic Marketing/Digital Entrepreneurship	1	
		Software Development	Conceptual Design of an IT Application	3	
			Information System Design	3	
			Summary Theory Exam	1	
			Licentiate Internship and Design	2	
		Software Quality	Software Quality/Analysis and Specification of Software Requirements	2	
C3 Application technologies	C3.1 Identifying and defining concepts, procedures and methods for information processing used in *application development depending on the human activity needs.* C3.2 Explaining technologies appropriate for developing applications required for the organizations activities. C3.3 Using modern technologies to define software applications. C3.4 Using criteria and methods determined by the application technologies to assess compliance with interoperability standards. C3.5 Developing software applications using advanced technologies to convey, store and process data in compliance with the organisation needs.	Architectures, Platforms and Technologies	Multimedia Technologies/Simulation and Modelling Techniques	3	52
			Personal and Professional Development/Computer Science and Society	1	
			IoT Projects	2	
			Embedded Systems	3	
			Mobile Application Development/WEB Programming	1	
		Information Management	Databases	5	
			Conceptual Design of an IT Application	2	
			Foundations of Artificial Intelligence/Non-relational Databases	2	
		Programming	Basics for Application Development	4	
			Developing Secure Applications	4	
			Equivalent Models	2	
			Developing Industry Specific Languages	2	
			Network Programming	2	
			Object Oriented Programming	2	
			Information System Design	3	
			Programming of Distributed Applications	2	
			Data Analysis and View/ Computer Graphics	2	
			Software Design Techniques and Mechanisms Software Verification and Validation	2	
			Mobile Application Development/WEB Programming	2	
			Foundations for Game Development/ Technologies of Mixed Reality	2	
			Licentiate Internship and Design	3	

			Summary Theory Exam	1	
C4 Software development methods and technologies	C4.1 Identifying and defining concepts and methods focused on *software development, implementation and utilization process.* C4. Explaining concepts and methods used for software development, implementation and use. C4.3 Applying programming languages, modelling and development environment, methodologies to produce software. C4.4 Using criteria and methods to assess the *system development process in terms of its quality and performance*. C4.5 Developing and implementing software for specific problems from diverse areas of human activity.	Programming	Object Oriented Programming	3	54
			Network Programming	2	
			IoT Projects	4	
			Embedded Systems	2	
			Programming of Distributed Applications	2	
			Data Analysis and View/ Computer Graphics	2	
			Multimedia Technologies/Simulation and Modelling Techniques	2	
			Human-Computer Interaction/ Real Time Programming	3	
			Mobile Application Development/WEB Programming	1	
		Software development	Basics for Application Development	4	
			Developing Secure Applications	3	
			Developing Industry Specific Languages	2	
			Conceptual Design of an IT Application	2	
			Cryptography and Security	3	
			Information System Design	2	
			Foundations of Artificial Intelligence/Non-relational Databases	3	
			Foundations for Game Development/technologies of Mixed Reality	3	
			Summary Theory Exam	1	
			Licentiate Internship and Design	3	
			Defending the Licentiate Project	1	
		Software Quality	Software Design Techniques and Mechanisms Software Verification and Validation	3	
			Software Quality/Analysis and Specification of Software Requirements	3	
C5 Computing systems architecture and infrastructure	C5.1 Identifying and defining hardware, software and communication architecture components, as well as those required for *the description of a computing infrastructure.* C5.2 Explaining the interaction and functioning of architecture and infrastructure components.	Programming	Programming of Distributed Applications	1	24
			Mobile Application Development/*WEB Programming*	1	
			Network Programming	1	
			Licentiate Internship and Design	2	
		Networks and Data Communications	Computer Network	5	
			IoT Projects	2	

	C5.3 Applying basic methods to specify architecture and infrastructure solutions for typical computing issues. C5.4 Using criteria and methods to *assess the functional and non-functional features of system components*. C5.5 Implementing architecture and infrastructure solutions based on constraints defined by the project.	Architectures, platforms and Technologies	Computer Architecture	5	
			Operating Systems: Internal Mechanisms and Design Principles	5	
			Human-Computer Interaction/*Real Time Programming*	2	

Crosscutting Competences	**Subjects of Study**	**Credits**	
		Per Subject	**Per Competence**
CT1. Applying principles, rules and values of professional ethics	Ethics, Communication and Law	3	**8**
	Conceptual Design of an IT Application	1	
	Personal and Professional Development/Computer Science and Society	1	
	Project Management/Enterprise Management	1	
	Electronic Marketing/Digital Entrepreneurship	1	
	Licentiate Internship and Design	1	
CT2. Identifying, describing and unrolling the team activities aimed to develop communication and collaboration skills and to undertake different roles (executive and management roles).	Equivalent Models	2	**9**
	Developing Industry Specific Languages	1	
	Conceptual Design of an IT Application	1	
	Basics for Application Development	1	
	Developing Secure Applications	1	
	IoT Projects	1	
	Information System Design	1	
	Licentiate Internship and Design	1	
CT3. Demonstrating the spirit of initiative and action for refreshing the professional, economic and organizational culture knowledge.	Equivalent Models	1	**8**
	Developing Industry Specific Languages	1	
	Conceptual Design of an IT Application	1	
	Basics for Application Development	1	
	Developing Secure Applications	1	
	IoT Projects	1	
	Information System Design	1	
	Licentiate Internship and Design	1	
Total per Study Programme			**240**

Annex 6: Educational plan on components implemented from 1 September 2017

Technical University of Moldova

Faculty of Computer Science, Informatics and Microelectronics

„APPROVED”

TUM Senate meeting

minutes no. 4

of „*27” december 2016*

Chairman of the UTM Senate

Rector, dr. hab.

Viorel Bostan_____ _____

„ APPROVED”

Minister of Education of the Republic of Moldova

_____

”___” _____2017

"___" _____2017

Registration nr. _____

EDUCATIONAL PLAN

for the first cycle, Bachelor’s degree studies (level 6 according to ISCED)

***General field of study**: 061 Information and communication technologies*

***Professional training field**:* 0613 Development of programme products and applications

***Study programme**:* 0613.3 Software Engineering

***Total no. of ECTS study credits**:* 240

***Title conferred**:* Bachelor engineer

***Certification**:* Bachelor's degree

Admission basis: baccalaureate diploma or equivalent study document; higher education diploma

***Language of instruction**:* Romanian, Russian, English

***Form of organization of education**:* full-time education

1. UNIVERSITY CALENDAR

Year of study	Didactic activities		Examination sessions		Internships	Holidays		
	sem. I	sem. II	sem. I	sem. II		Winter	Spring	Summer
I	15 weeks	15 weeks	4 weeks	4 weeks		2 weeks	Holiday for Easter holidays, 1 week (according to the Christian calendar)	10 weeks
II	15 weeks	15 weeks	4 weeks	4 weeks	15 weeks	2 weeks		6 weeks
III	15 weeks	15 weeks	4 weeks	4 weeks	15 weeks	2 weeks		6 weeks
IV	15 weeks	7 weeks	4 weeks	2 weeks	10 weeks	2 weeks		9 weeks

2. Educational plan by components

Code	Name of the study discipline	Department	assessments		Credit points	Number of contact hours				Individual work	Year I		Year II		Year III		Year IV	
			Exam	Year project		Total	Lectures	Seminars / Internships	Project		Sem 1	Sem 2	Sem 3	Sem 4	Sem 5	Sem 6	Sem 7	Sem 8
Fundamental disciplines																		
F.01.O.001	Mathematics	ISA	1		5	75	45	30		75	75							
F.01.O.002	Computer programming	ISA	1		5	75	30	15	30	75	75							
F.01.O.003	Special Mathematics 1	ISA	1		5	75	30	45		75	75							
F.02.O.004	Equivalent models	ISA		2	10	150			150	150		150						
F.02.O.005	Applied Sciences	ISA	2		5	75	30	15	30	75		75						
F.02.O.006	Special Mathematics 2	ISA	2		5	75	30	15	30	75		75						
F.02.O.007	Computer architecture	ISA	2		5	75	30	45		75		75						
F.02.O.008	Data Structures and Algorithms	ISA	2		5	75	30	30	15	75		75						
F.04.O.009	Developing domain-specific languages	ISA		4	10	150			150	150				150				
F.04.O.010	Formal languages and compilers design	ISA	4		5	75	30	15	30	75				75				
F.04.O.011	Calculability and complexity	ISA	4		5	75	30	15	30	75				75				
F.06.O.012	Signal processing	ISA	6		5	75	30	30	15	75						75		
Total fundamental disciplines:			**10**	**2**	**70**	**1050**	**315**	**255**	**480**	**1050**	**225**	**450**	**0**	**300**	**0**	**75**	**0**	**0**
Disciplines for general skills and competences training																		
G.01.O.013	Conceptual design of an IT application	ISA		*1*	10	150			150	150	150							
G.01.O.014 *G.01.O.014*	Foreign language 1	ISA	*1*		*3*	*45*		*45*		*45*	*45*							
G.01.O.015	Romanian language (for speakers of other languages) 1 *	ISA	*1*		*2*	*30*		*30*		*30*	*30*							
G.01.O.016	Physical Education 1 *	ISA	*1*			*30*		*30*		*30*	*30*							
G.02.O.017	Foreign Language 2	ISA *ISA*	*2* *2*		*3* *3*	*45* *45*		*45* *45*		*45* *45*		*45* *45*						
G.02.O.018	Romanian language (for speakers of other languages) 2 *	ISA	*2*		*2*	*30*		*30*		*30*		*30*						
G.02.O.019	Physical Education 2 *	ISA	*2*			*30*		*30*		*30*		*30*						
G.05.O.020	Ethics, communication and law	ISA	5		5	75	45	30		75					75			
Total disciplines of general skills and competences training:			**7**	**1**	**15**	**225**	**45**	**30**	**150**	**225**	**150**	**0**	**0**	**0**	**75**	**0**	**0**	**0**
Socio-humanistic orientation disciplines																		
U.01.A.021 *U.01.A.022*	Personal and professional development *Computer science and society*	ISA	1		5	75	30	30	15	75	75							

U.07.A.023 *U.07.A.024*	Project Management *Enterprise Management*	ISA	7		5	75	30	30	15	75							75	
U.07.A.025 *U.07.A.026*	Electronic marketing *Digital entrepreneurship*	ISA	7		5	75	30	30	15	75							75	
Total social-humanistic orientation disciplines:			**3**	**0**	**15**	**225**	**90**	**90**	**45**	**225**	**75**	**0**	**0**	**0**	**0**	**0**	**150**	**0**
Compulsory specialization orientation disciplines																		
S.03.O.027	The Basics of Applications Development	ISA		3	10	150			150	150			150					
S.03.O.028	Object Oriented Programming	ISA	3		5	75	30	15	30	75			75					
S.03.O.029	Computer networks	ISA	3		5	75	30	45		75			75					
S.03.O.030	Database	ISA	3		5	75	30	15	30	75			75					
S.04.O.031	Operating systems: internal mechanisms and design principles	ISA	4		5	75	30	45		75				75				
S.05.O.032	Developing secure applications	ISA		5	10	150			150	150					150			
S.05.O.033	Network programming	ISA	5		5	75	30	15	30	75					75			
S.05.O.034	Cryptography and security	ISA	5		5	75	30	15	30	75					75			
S.06.O.035	IoT projects	ISA		6	10	150			150	150						150		
S.06.O.036	Embedded systems	ISA	6		5	75	30	15	30	75						75		
S.07.O.037	Design of information systems	ISA		7	10	150			150	150							150	
S.07.O.038	Programming Distributed Applications	ISA	7		5	75	30	15	30	75							75	
Total disciplines of compulsory specialization orientation:			**8**	**4**	**80**	**1200**	**240**	**180**	**780**	**1200**	**0**	**0**	**375**	**75**	**300**	**225**	**225**	**0** *0*
Disciplines of optional specialization orientation																		
S.03.A.039 *S.03.A.040*	Data analysis and visualization *Computer Graphics*	ISA	3		5	75	30	30	15	75			75					
S.04.A.041 *S.04.A.042*	Multimedia technologies *Simulation and modeling techniques*	ISA	4		5	75	30	30	15	75				75				
S.05.A.043 *S.05.A.044*	Techniques and mechanisms of software design *Verification and validation of programme products*	ISA	5		5	75	30	30	15	75					75 *75*			
S.06.A.045 *S.06.A.046*	Man-computer interaction *Real time programming*	ISA	6		5	75	30	15	30	75						75		
S.06.A.047 *S.06.A.048*	Mobile applications programming *Web programming*	ISA	6		5	75	30	15	30	75						75		
S.07.A.049 *S.07.A.050*	Software quality *Analysis and specification of software requirements*	ISA	7		5	75	30	30	15	75							75	
S.08.A.051 *S.08.A.052*	Fundamentals of Artificial Intelligence *Unrelated databases*	ISA	8		5	75	30	45		75								75

S.08.A.053 *S.08.A.054*	Fundamentals of Games Development *Mixed reality technologies*	ISA	8		5	75	30	45		75								75
Total disciplines of optional specialization orientation:			**8**	**0**	**40**	**600**	**240**	**240**	**120**	**600**	**0**	**0**	**75**	**75**	**75**	**150**	**75**	**150**
Total number of study hours:						3300	930	795	1575	3300	450	450	450	450	450	450	450	150
S.08.O.055	Internship and Bachelor's degree project	ISA	8		15					***450***								450
S.08.O.056	Theoretical synthesis test: Algorithms, programming and databases	ISA	8		4					**120**								120
S.08.O.057	Defence of the Bachelor's degree project	ISA	8		1					**30**								30
Number of hours per week											30	30	30	30	30	30	30	
Number of examinations in examination sessions			33								4	4	4	4	4	4	4	5
Number of projects			7								1	1	1	1	1	1	1	
Number of credit points					**240**	**3300**	930	795	1575	**3900**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**

* It is not calculated in the total amount of the assessment forms (because the courses "Romanian Language" (for speakers of other languages) and "Physical Education" are done in extracurricular regime, the course unit "Romanian Language" (for speakers of other languages) is allocated additional credits to those 240 credits per programme, and the course unit "Physical Education" is not quantified with credits).

Approved at the TUM Senate meeting,
minutes no. 4 of 27.12.2016

Ion BALMUȘ — The Dean of the Faculty CSIM, assoc. prof, PhD

Dumitru CIORBĂ — Head of the Department of Software Engineering and Automatics, assoc. prof, PhD

Annex 7: Grid 1L - Description of the study field / programme through professional and transversal competences

Title of qualification: Software Engineering Level of qualification: Bachelor		**Possible occupations (according to CORM): *25 Specialists in Information and Communication Technology*** • *251 Software Programming Analysts* (2511 System Analysts, 2512 Software Developers, 2513 Web and Multimedia Designers, 2514 Applications Programmers, 2519 Software Programme Analysts unclassified in earlier basic groups)			
Professional competences **Level descriptors of structural elements of professional competences**	**C1** **On the scientific and engineering fundamentals of information technologies**	**C2** **On the organizational and informational aspects of the systems**	**C3** **On applications technologies**	**C4** **On software development methods and technologies**	**C5** **On the architecture and infrastructure of computer systems**
Knowledge					
D1 Knowledge, understanding of the concepts, theories and basic methods of the domain and of the specialization area; their proper use in professional communication	C1.1 Identifying and defining concepts, theories and methods of *fundamental and applied sciences* support for information technology engineering	C2.1 Identifying and defining the concepts, theories and methods used to carry out *human-centered analyzes and information* on systems operating at the level of organizations	C3.1 Identifying and defining the concepts, processes and methods of information processing used in the realization of *applications arising from the needs* of human activity	C4.1 Identifying and defining concepts and methods focused on the *development, implementation and use* of software	C5.1 Identifying and defining architectural hardware, software and communications components, as well as those needed to *describe a computing infrastructure*
D2 Using basic knowledge to explain and interpret various types of concepts, situations, processes, projects, etc. associated with the domain	C1.2 Explaining engineering solutions by using techniques, concepts and principles in exact and applicative sciences	C2.2 Explaining the concepts, theories and methods used to carry out analyzes of systems operating at the level of organizations	C3.2 Explaining the right technologies for making the necessary applications in organizations' activities	C4.2 Explaining the concepts and methods used to develop, implement and use the software	C5.1 Explaining the interaction and functioning of architectural and infrastructure components
Abilities					
D3 Applying basic principles and methods for solving well-defined issues / situations, typical of the field under qualified assistance	C1.3 Solving problems in human activity fields by applying in particular numerical techniques and methods	C2.3 Applying concepts, theories and basic methods for preparing the information needed for system development	C3.3 Using modern technologies in defining software applications	C4.3 Applying programming languages, modeling and development environments, and methodologies for software creation	C5.3 Apply basic methods for specifying architectural and infrastructure solutions for computational problems
D4 Appropriate use of standard criteria and assessment methods to assess the quality,	C1.4 Choosing the criteria and methods for analyzing the	C2.4 Choosing the criteria and methods for assessing the	C3.4 Using criteria and methods determined by application	C4.4 Using criteria and methods to evaluate the system design process in	C5.4 Using criteria and methods to evaluate functional and non-functional features

merits and limits of processes, programmes, projects, concepts, methods and theories	advantages and disadvantages of the methods and procedures applied to solving the numerical calculus problems.	quality, performance and limits of the systems to be developed in accordance with the needs of the organization, including those needed to define a quality and security management system	technologies to assess compliance with interoperability standards	terms of quality and performance	of system components
D5 Developing professional projects with the use of established principles and methods in the field	C1.5 Modeling of typical problems in applied sciences using the mathematical apparatus	C2.5 Elaboration of a project (system specification) under the conditions of a quality and security management system.	C3.5 Developing software applications using modern technologies for transmitting, storing and processing data in accordance with what is needed	C4.5 Development and implementation of software for concrete problems in various fields of human activity	C5.5 Implementation of an architectural and infrastructure solution based on constraints of the project.
Minimum performance standards for competence assessment	Identifying and applying methods and algorithms learned for standard problems of fundamental and applied sciences.	Analysis and modeling of a system oriented on a organizational and / or informational problem of a human activity domain.	Identifying and using the technologies needed to develop a software application.	Analysis and modeling and realization of a functional prototype in accordance with technological development processes	Identifying hardware, software, and communications components for applications specific to the selected domain

Level descriptors of the structural elements of professional competences	**Transversal competences**	**Minimum performance standards for competence assessment**
D6. Responsible execution of professional tasks, in restricted conditions and qualified assistance	CT1. Applying the principles, norms and values of professional ethics	Carrying out projects in accordance with the rules of professional ethics
D7. Familiarizing with the roles and tasks specific to teamwork and the distribution of tasks for the subordinate levels	CT2. Identifying, describing and running the activities organized in a team with the development of the communication and collaboration capacities, as well as assuming the different roles (execution and leadership)	Carrying out a project in the team with the responsible assumption of different roles
D8. Awareness of the need for continuous training, the efficient use of resources and learning techniques for personal and professional development	CT3. Demonstrate the spirit of initiative and action to up-date professional, economic and organizational culture	Developing and implementing a personal development plan; project communication in Romanian / Russian and in English / French.

Annex 8: Grid 2L - Coordination between developed competences and course units / modules

Professional competences	competences explained by level descriptors	Content areas	Study disciplines	Credits	
				On discip-line	On com-pe-tence
1	2	3	4	5	6
C1 On the scientific and engineering foundations of information technologies	C1.1 Identifying and defining concepts, theories and methods of *fundamental and applied sciences* support for information technology engineering C1.2 Explanation of engineering solutions using techniques, concepts and principles from the exact and applicative sciences C1.3 Solving problems in human activities by applying in particular numerical computing techniques and methods C1.4 Choosing the criteria and methods for analyzing the advantages and disadvantages of the methods and procedures applied to the solution of *numerical computational problems.* C1.5 Modeling of typical problems in applied sciences using the mathematical apparatus	Exact and applicative sciences	Mathematics	5	**67**
			Special Mathematics 1	5	
			Special Mathematics 2	5	
			Equivalent models	5	
			Applied Sciences	5	
			Signal processing	5	
			Personal and professional development / Computer science and society	1	
			Project Management / Enterprise Management	2	
			Electronic Marketing / Digital Entrepreneurship	2	
			Cryptography and security	1	
			Database	2	
		Programming	Computer programming	5	
			Data Structures and Algorithms	5	
			Formal languages and compiler design	5	
			Calculability and complexity	5	
			Data Analysis and Visualization / Computer Graphics	2	
			Developing domain-specific languages	4	
			Internship and Bachelor's degree project	2	
			Theoretical synthesis test	1	
C2 Regarding organizational and informational aspects of systems	C2.1 Identifying and defining the concepts, theories and methods used to carry out human-focused analyzes and information on systems operating at the level of organizations C2.2 Explaining the concepts, theories and methods used to carry out analyzes on systems operating at the level of organizations C2.3 Application of concepts, theories and basic methods for the preparation of information necessary for the development of systems operating at the level of organizations C2.4 Choosing the criteria and methods for assessing the quality, performance and limits of the systems to be developed in accordance with the needs	Information security	Ethics, communication and law	2	**15**
			Developing secure applications	1	
			Cryptography and security	1	
		Information Management	Project Management / Enterprise Management	1	
			Electronic Marketing / Digital Entrepreneurship	1	
		Software development	Conceptual design of an IT application	2	
			Design of information systems	2	
			Theoretical synthesis test	1	
			Internship and Bachelor's degree project	2	

	of the organization, including those needed to define a quality and security management system C2.5 Elaboration of a project (system specification) under the conditions of a quality and security management system.				
		Software quality	Software Quality / Analyzing and Specifying Software Requirements	2	
C3 Regarding applications technologies	C3.1 Identifying and defining the concepts, processes and methods of information processing used in the realization of applications *arising from the needs* of human activity C3.2 Explaining the right technologies for making the necessary applications in organizations' activities C3.3 Use of modern technologies in defining software applications C3.4 Use of criteria and methods determined by application technologies to assess compliance with interoperability standards C3.5 Development of software applications using modern technologies for transmitting, storing and processing data according to the needs of an organization	Architectures, platforms and technologies	Multimedia Technologies / Simulation and Modeling Techniques	3	**47**
			Personal and professional development / Computer science and society	1	
			IoT projects	2	
			Embedded systems	3	
			Mobile Applications Programming / Web Programming	1	
			Computer networks	2	
		Information Management	Database	3	
			Conceptual design of an IT application	1	
			Fundamentals of Artificial Intelligence / Unrelated Databases	2	
		Programming	The Basics of Applications Development	3	
			Developing secure applications	3	
			Equivalent models	1	
			Developing domain-specific languages	2	
			Network programming	2	
			Object Oriented Programming	2	
			Design of information systems	3	
			Programming Distributed Applications	2	
			Data Analysis and Visualization / Computer Graphics	1	
			Techniques and mechanisms of software design Verification and validation of programme products	2	
			Mobile Applications Programming / Web Programming	2	
			Fundamentals of Games Development / Mixed Reality Technologies	2	
			Internship and Bachelor's degree project	3	
			Theoretical synthesis test	1	
C4 Regarding software development	C4.1 Identifying and defining concepts and methods focused on the	Programming	Object Oriented Programming	3	**52**
			Network programming	2	
			IoT projects	4	

methods and technologies	*development, implementation and use* of software C4.2 Explaining the concepts and methods used to develop, implement and use the software C4.3 Application of programming languages, modeling and development environments, methodologies for software creation C4.4 Use of criteria and methods to evaluate the *process* of systems development in terms of quality and performance C4.5 Development and implementation of software for concrete problems in various fields of human activity		Embedded systems	2	
			Programming Distributed Applications	2	
			Data Analysis and Visualization / Computer Graphics	2	
			Multimedia Technologies / Simulation and Modeling Techniques	2	
			Human-computer interaction / real-time programming	3	
			Mobile Applications Programming / Web Programming	1	
		Software development	The Basics of Applications Development	4	
			Developing secure applications	3	
			Developing domain-specific languages	1	
			Conceptual design of an IT application	1	
			Cryptography and security	3	
			Design of information systems	2	
			Fundamentals of Artificial Intelligence / Unrelated Databases	3	
			Fundamentals of Games Development / Mixed Reality Technologies	3	
			Theoretical synthesis test	1	
			Internship and Bachelor's degree project	3	
			Defence of the Bachelor's degree project	1	
		Software quality	Techniques and mechanisms of software design Verification and validation of programme products	3	
			Software Quality / Analyzing and Specifying Software Requirements	3	
C5 Regarding the architecture and infrastructure of computing systems	C5.1 Identifying and defining architectural hardware, software and communications components, as well as those needed *to describe a computing infrastructure* C5.2 Explaining the interaction and functioning of architectural and infrastructure components C5.3 Application of basic methods for specifying architectural and infrastructure solutions for typical computing problems C5.4 Use of criteria and methods for evaluating *functional and non-*	Programming	Programming Distributed Applications	1	**20** *20*
			Mobile Applications Programming / Web Programming	1	
			Network programming	1	
			Internship and Bachelor's degree project	1	
		Networks and data communications	Computer networks	3	
			IoT projects	1	
			Computer architecture	5	

	functional features of system components C5.5 Implementation of an architectural and infrastructure solution based on stated constraints	Architectures, platforms and technologies	Operating systems: internal mechanisms and design principles	5	
			Human-computer interaction / real-time programming	2	

Transversal competences	**Study disciplines**	**Credits**	
		On discipline	**On competence**
CT1. Applying the principles, norms and values of professional ethics	Ethics, communication and law	3	**17**
	Conceptual design of an IT application	2	
	Personal and professional development / Computer science and society	3	
	Project Management / Enterprise Management	1	
	Electronic Marketing / Digital Entrepreneurship	1	
	Equivalent models	1	
	The Basics of Applications Development	1	
	Developing domain-specific languages	1	
	Developing secure applications	1	
	IoT projects	1	
	Design of information systems	1	
	Internship and Bachelor's degree project	1	
CT2. Identifying, describing and running the activities organized in a team with the development of the communication and collaboration capacities, as well as assuming the different roles (execution and leadership)	Equivalent models	2	**10**
	Developing domain-specific languages	1	
	Conceptual design of an IT application	2	
	The Basics of Applications Development	1	
	Developing secure applications	1	
	IoT projects	1	
	Design of information systems	1	
	Internship and Bachelor's degree project	1	
CT3. Demonstrate the spirit of initiative and action to update own professional, economic and organizational culture knowledge	Project Management / Enterprise Management	1	**12**
	Electronic Marketing / Digital Entrepreneurship	1	
	Equivalent models	1	
	Developing domain-specific languages	1	
	Conceptual design of an IT application	2	
	The Basics of Applications Development	1	
	Developing secure applications	1	
	IoT projects	1	
	Design of information systems	1	
	Internship and Bachelor's degree project	2	
Total study programme			**240**

Annex 9: Roadmap

	2015			2016											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beginning of the project	15														
The preparation stage															
Mobility to study the current situation at EU Partner Universities															
Teacher training during trainings organized by MD and EU partners															
Developing and approval of the legal framework for launching the new study programme															
Preparing infrastructure for teaching based on PBL Methodology															
Internal evaluation and obtaining provisional authorization															
Preparing curricula for disciplines for the first year of study															
Admission 2017															
Implementation stage															
1 September 2017 - Launch of the first year of study - SE specialty															
Initiating students in the new PBL teaching methodology															
Identifying team mentors															
Identifying and teamwork with students															
Conducting the learning process based on the PBL-based study programme															
Training of teachers involved in teaching															
Identifying and teamwork with students															
Accreditation of the study programme															
Study visits of MD students to Universities in the EU															
Teaching visits of EU teachers to MD															
Promotion															
Promoting the ERASMUS + PBLMD project															
Promotion of the Software Engineering study programme															*W50: Dec 15*

	2017											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beginning of the project												
The preparation stage												
Mobility to study the current situation at EU Partner Universities												
Teacher training during trainings organized by MD and EU partners												
Development and approval of the legal framework for launching the new study programme												

Preparing infrastructure for teaching based on PBL methodology												
Internal evaluation and obtaining provisional authorization												
Preparing curricula for disciplines for the first year of study												
Admission 2017												
Implementation stage												
1 September 2017 - Launch of the first year of study - SE specialty												
Initiating students in the new PBL teaching methodology												
Identifying team mentors												
Identifying and teamwork with students												
Conducting the learning process based on the PBL-based study programme												
Training of teachers involved in teaching												
Identifying and teamwork with students												
Accreditation of the study programme												
Study visits of MD students to Universities in the EU												
Teaching visits of EU teachers to MD												
Promotion												
Promoting the ERASMUS + PBLMD project												
Promotion of the Software Engineering study programme												

	2018											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beginning of the project												
The preparation stage												
Mobility to study the current situation at EU Partner Universities												
Teacher training during trainings organized by MD and EU partners												
Developing and approval of the legal framework for launching the new study programme												
Preparing infrastructure for teaching based on PBL methodology												
Internal evaluation and obtaining provisional authorization												
Preparing curricula for disciplines for the first year of study												
Admission 2017												
Implementation stage												
1 September 2017 - Launch of the first year of study - SE specialty												
Initiating students in the new PBL teaching methodology												
Identifying team mentors												
Identifying and teamwork with students												
Conducting the learning process based on the PBL-based study programme												
Training of teachers involved in teaching												
Identifying and teamwork with students												
Accreditation of the study programme												
Study visits of MD students to Universities in the EU												
Teaching visits of EU teachers to MD												

Promotion												
Promoting the ERASMUS + PBLMD project												
Promotion of the Software Engineering study programme												

	2019									
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Beginning of the project										
The preparation stage										
Mobility to study the current situation at EU Partner Universities										
Teacher training during trainings organized by MD and EU partners										
Developing and approval of the legal framework for launching the new study programme										
Preparing infrastructure for teaching based on PBL methodology										
Internal evaluation and obtaining provisional authorization										
Preparing curricula for disciplines for the first year of study										
Admission 2017										
Implementation stage										
1 September 2017 - Launch of the first year of study - SE specialty										
Initiating students in the new PBL teaching methodology										
Identifying team mentors										
Identifying and teamwork with students										
Conducting the learning process based on the PBL-based study programme										
Training of teachers involved in teaching										
Identifying and teamwork with students										
Accreditation of the study programme										
Study visits of MD students to Universities in the EU										
Teaching visits of EU teachers to MD										
Promotion										
Promoting the ERASMUS + PBLMD project										
Promotion of the Software Engineering study programme										

Annex 10: Action plan

Preparing for the launch of the new study programme	
Action 1	Documentation visits to partner universities: Royal Institute of Technology, Sweden (KTH), Aalborg University in Denmark, (AAU), University of Gloucestershire (UoG). Cross analysis of study programmes at AAU, UoG, KTH.
Action 2	Training of teachers to use the PBL methodology. Participating in trainings organized under the project at TUM or AESM during 2016-2018. Academic mobility of teachers at the partner universities of the European Union.
Action 3	Preparing infrastructure for teaching based on the PBL methodology consists in purchasing equipment and preparing study rooms, which will be team-oriented.
Action 4	Inclusion of the new specialty in the Nomenclature of Professional Training Fields and Specializations for Training of Staff in Higher Education Institutions, 1st Cycle
Action 5	Elaboration of the educational plan for "Software Engineering"
Action 7	Approval of the Study Programme at: - the department / chair - The faculty - The TUM Senate
Action 4	Internal and external evaluation of the study programme
Action 5	Obtaining authorization for provisional operation
Action 6	Advertising the new study programme
Action 7	Identifying the teachers who will be involved in the teaching process within the new study programme and train them for their use of the PBL teaching methodology.
Action 8	Elaboration of educational documents: curriculum by disciplines (analytical programmes), guides, case studies, evaluation etc. (for the first year of study).
Action 9	Admission to the “Software Engineering” study programme
Implementation	
Action 1	Admission 2017
Action 2	September 1, 2017 launching the new study programme.
Action 3	Conducting the study process, based on TUM regulations
Action 4	Obtaining accreditation for the next 5 years
Action 5	Elaboration of discipline sheets and curricula on disciplines for the next years of study
Action 6	Admission 2018
Promotion	
Action 1	Promoting the PBLMD project
Action 2	Promoting the study programme "Software Engineering"

Annex 11: The advertising flyer of the study programme 2017

Annex 12: Dissemination plan

ANNUAL DISSEMINATION PLAN

Dissemination activities	WP(s)	Dissemination vehicle, incl. link to the source	Timing/ frequency	Minimum number	Main target group(s)
REALIZED ACTIVITIES					
Article about ERASMUS + Key Action 2 – Capacity Building in Higher Education with mentioning the partners and objectives of the new project PBLMD	**WP1: Launch**	http://utm.md/blog/2015/11/06/erasmus-actiunea-cheie-2-consolidarea-capacitatilor-in-domeniul-invatamintului-superior/	**November 6, 2015**	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Article about the launching of a new project	**WP1: Launch**	http://utm.md/blog/2015/11/20/la-utm-a-demarat-un-nou-proiect-didactic-in-cadrul-programului-erasmus/	**November 19, 2015**	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Publication in Academic Messenger newspaper from Technical University of Moldova. About the start of the new programme ERASMUS+	**WP1: Launch**	Academic Messenger Year XVIII, No. 9 (179) Newspaper, TUM. Web-publication: http://utm.md/mesager/2015/mu-noiembrie-2015.pdf	**November, 2015**	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Project booklet	**WP1: Launch**	http://www.pblmd.aau.dk/fileadmin/user_upload/PBLMD_booklet_eng_print_2016_12.pdf	**Winter, 2015**	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Study visit	**WP2: Training in PBL methodology and methods**	http://utm.md/blog/2016/02/20/schimb-de-experienta-in-cadrul-proiectului-erasmus-pblmd-la-universitatea-din-aalborg-danemarca/	**February , 2016**	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Publication in Academic Messenger newspaper from Technical University of Moldova.	**WP2: Training in PBL methodology and methods**	Academic Messenger Year XIX, No. 3 (183) Newspaper, TUM. Web-publication: http://utm.md/mesager/2016/mu-martie-2016.pdf	March, 2016	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Publication in Academic Messenger newspaper from Technical University of Moldova.	**WP2: Training in PBL methodology and methods**	Academic Messenger Year XIX, No. 4 (185) Newspaper, TUM http://utm.md/mesager/2016/mu-mai-iunie-2016.pdf	May-June 2016	**All interested parties (professors, students etc.).**	**Academic staff, students.**

Europe day in Chisinau, Moldova Promotion of the PBLMD project	**WP2:** **Training in PBL methodology and methods**	http://utm.md/blog/2016/06/29/europe-day-in-chisinau-moldova/	June, 2016	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Study visit	**WP2:** **Training in PBL methodology and methods**	http://utm.md/blog/2016/09/28/profesorii-utm-insusesc-metode-moderne-de-predare-in-suedia/	September, 2016	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Article "The consortium assesses the ERASMUS + implementation"	**WP2:** **Training in PBL methodology and methods**	http://utm.md/blog/2016/10/25/consortiul-evalueaza-implementarea-proiectului-erasmus-privind-pbl/	October, 2016	**All interested parties (professors, students etc.).**	**Academic staff, students.**
International conference "When Students Take the Lead: Enhancing Quality and Relevance of Higher Education through Innovation in Student-Centered Problem-Based Active Learning"	**WP3: In depth analysis of context factors and curricular content**	http://utm.md/blog/2016/11/07/inovatii-in-invatarea-bazata-pe-pbl/	October 27-28, 2016	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Publication in Academic Messenger newspaper from Technical University of Moldova.	**WP3: In depth analysis of context factors and curricular content**	Academic Messenger Year XVIII, No. 8 (188) Newspaper, TUM http://utm.md/mesager/2016/mu-octombrie-2016.pdf	October ,2016	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Mobility visits	**WP3: In depth analysis of context factors and curricular content**	http://utm.md/blog/2016/11/23/noi-mobilitati-la-universitatea-din-aalborg/	November, 2016	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Publication in Academic Messenger newspaper from Technical University of Moldova.	**WP3: In depth analysis of context factors and curricular content**	Academic Messenger Year XVIII, No. 9 (189) Newspaper, TUM http://utm.md/mesager/2016/mu-noiembrie-2016.pdf	November, 2016	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Mobility visit, pedagogical team	**WP3: In depth analysis of context factors and curricular content**	https://www.facebook.com/pg/pblmd.erasmusplus/photos/?tab=album&album_id=690464361146214	March-April ,2017	**All interested parties (professors, students etc.) who accesses the utm.md website.**	**Academic staff, students.**
Mobility visit	**WP4: PBL study programme and curricula development**	http://utm.md/blog/2017/04/23/vizita-de-studiu-la-kth-royal-institute-of-technology-stockholm/ https://www.facebook.com/SEADMoldova/?fref=mentions&pnref=story https://www.facebook.com/pg/UTMoldova/posts/?ref=page_internal	April ,2017	**All interested parties (professors, students etc.).**	**Academic staff, students.**

Article "PBLMD: Training about using the Adobe Connect"	**WP4: PBL study programme and curricula development**	http://utm.md/blog/2017/04/29/pblmd-training-privind-utilizarea-platformei-adobe-connect/ https://www.facebook.com/pg/UTMoldova/posts/?ref=page_internal	April ,2017	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Promotion of the project PBLMD and the new study programme at the Amdaris StandUP	**WP4: PBL study programme and curricula development**	https://www.facebook.com/photo.php?fbid=10155260361567290&set=a.10155260361542290.1073741837.837082289&type=3&theater	April ,2017	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Press conference	**WP4: PBL study programme and curricula development**	https://www.youtube.com/watch?v=laZ9jRr3Hf8&feature=share https://www.facebook.com/pblmd.erasmusplus/ http://utm.md/blog/2017/05/29/pblmd-6-programe-de-studii-reproiectate-in-baza-unui-concept-nou/ https://www.facebook.com/pg/UTMoldova/posts/?ref=page_internal https://www.facebook.com/SEADMoldova/?fref=mentions&pnref=story	May 29, 2017	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Publication in Academic Messenger newspaper from Technical University of Moldova.	**WP4: PBL study programme and curricula development**	Academic Messenger Year XIX, No. 5 (195) Newspaper, TUM http://utm.md/mesager/2017/mu-mai-iun-2017.pdf	May-June 2017	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Publication of the new study programme plan and admission to the new study programme	**WP5:Implementation of the study programmes and sustainability actions**	http://utm.md/studii/planuri/2016/fcim/Plan%20ISW.pdf	Summer, 2017	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Admission to the new study programme	**WP5:Implementation of the study programmes and sustainability actions**	utm.md/admiterea-utm/	July-August, 2017	**All interested parties (professors, students etc.).**	**Students**
Launching the new study programme	**WP5:Implementation of the study programmes and sustainability actions**	https://www.facebook.com/SEADMoldova/?fref=mentions&pnref=story	September, 2017	**All interested parties (professors, students etc.).**	**Students**
PLANNED ACTIVITIES					
Organization of the methodical seminars at the ISA department with invitation of the professors from other departments.	**WP5:Implementation of the study programmes and sustainability actions**	www.facebook.com	Once in one-two months	**Up to 6-8 people**	**Academic staff.**

Presentation of the scientific article at the International Conference on Microelectronics and Computer Science, Technical University of Moldova.	**WP5: Implementation of the study programmes and sustainability actions**	www.icmcs.utm.md	19-21 October	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Publications in the Academic Messenger newspaper from Technical University of Moldova.	**WP5: Implementation of the study programmes and sustainability actions**	utm.md/mesager/anii.html	Autumn 2017, Winter 2018, Spring 2018, Autumn 2018	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Publications at the institutional website.	**WP5: Implementation of the study programmes and sustainability actions**	www.utm.md	Autumn 2017 Spring 2018 Autumn 2018	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Visits the IT companies with promotion the new study programme	**WP5: Implementation of the study programmes and sustainability actions**	www.facebook.com	Autumn 2017 Spring 2018 Autumn 2018	**All interested parties (professors, students etc.).**	**Academic staff, students.**
Promotion the events and activities that take place at the IS speciality.	**WP5: Implementation of the study programmes and sustainability actions**	www.facebook.com	Autumn 2017 Spring 2018 Autumn 2018	**All interested parties (professors, students etc.).**	**Academic staff, students.**