



Univerza v Novém městě
University of Nové Město

DOCTORAL STUDY PROGRAMME 3rd CYCLE

**SUSTAINABLE TECHNOLOGIES AND SYSTEMS IN MECHANICAL
ENGINEERING**

**implemented by University of Nové Město
Faculty of Mechanical Engineering**

KAZALO

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1 GENERAL INFORMATION ABOUT THE PROGRAMME

Study programme:	Sustainable Technologies and Systems in Mechanical Engineering
Cycle:	3rd cycle
Klasius SRV:	No. 18 202 - doctoral (3rd Bologna level)
Duration:	3 year
ECTS amount:	180 ECTS
Klasius P-16:	No. 0715 - Metallurgy, mechanical engineering, metall work
Research area (Frascati classification):	technical sciences
SOK (Slovenian classification framework)	level 10
EOK (European classification framework)	level 8
EOVK (European higher education classification framework)	Third level
Accreditation:	NAKVIS, decision No. 6033-8/2016/12 of 15 September 2016

2 FUNDAMENTAL OBJECTIVES AND COMPETENCES

2.1 Fundamental objectives of the study programme

The fundamental objective of the study programme is to train successful 2nd cycle master's students with great potential for development in the fields of technology and natural sciences, and to enable them for to conduct independent scientific research work and create new knowledge in the field of sustainable technologies and systems in mechanical engineering.

The research assignment that the doctoral student solves within the framework of the doctoral work is only a concrete example of the content where the candidate is familiarised with the elements and methodology of scientific research work and acquires the expected competencies (items 9 and 10 below). The main purpose is that later on he/she will be able to successfully transfer and apply them in other circumstances when solving other development and research tasks, e.g. in research and development departments of companies, in research laboratories of research institutes, in educational institutions, etc.

The training of doctoral students in the direction of creative scientific research and development work in the field of sustainable technologies and systems in mechanical engineering focuses on the development of knowledge and competences necessary for effective monitoring of the development of science in the world and effective teamwork, information exchange and interdisciplinary integration, while creating awareness of the importance of the application value of the results of development and research work

(from the basic idea to its implementation in the form of a final product) and the possibility of transferring new knowledge to a real industrial environment.

In this way, the programme aims to train doctoral students who, with their professional integrity, creativity and responsible and ethical behaviour, will effectively contribute to the design and development of new innovative solutions, taking into account the principles of co-natural sustainable development and who will thus be able to improve the competitiveness of the Slovenian economy on world markets.

2.2 General competences

General competences of a doctoral student:

- understanding of approaches, concepts and methodologies of scientific research work,
- a respectful attitude towards the creativity and achievements of past scientific research and development work of our ancestors,
- the ability to approach scientific research work in a systematic and structured manner,
- independent solving of scientific research and application tasks (from the formulation of the problem to the solution, i.e. to answer the posed question),
- the ability to observe and understand physical processes,
- the ability to predict outcomes,
- the ability to make critical judgments,
- communication skills to present and argue one's ideas, hypotheses and results to the scientific research and professional public on the broadest possible level,
- commitment to the ethics of scientific and research work.

2.3 Course-specific competences of the programme

Since the doctoral dissertation has a chosen content focus and content-specific objectives, it makes sense for the student to select courses from the curriculum that will provide him/her with the knowledge and subject-specific competences needed to successfully solve the scientific research problem he/she is working on. Despite the "tailor-made" choice of courses, the course-specific competences of the doctoral student can be summarised in the following sentences:

- the ability to understand and apply modern theories in the field of technical, technological and natural sciences,
- the ability to understand technical problems and use modern techniques and tools to solve them,
- the ability to integrate knowledge in an interdisciplinary manner,
- the ability to solve specific work problems in the field of technologies and systems,
- development of professional skills and abilities in the field of technologies and systems,
- the ability to develop new scientific research approaches and methods,
- the ability to plan and conduct experiments and to correctly select measurement methods for measuring physical quantities in various technological processes,
- active critical monitoring of the development of new methods and advanced materials in the field of technologies and systems,
- qualification for consulting activity (knowledge transfer).

3 INFORMATION ABOUT THE INTERNATIONAL COMPARABILITY OF THE PROGRAMME

The concept of the doctoral programme was established on the basis of an international comparison with a larger number of similar 3rd-cycle programmes conducted at various universities in the countries of the European Union. The comparison was mainly related to the content part of the programme implementation and not only to the formal requirements. Third-cycle programmes differ greatly in terms of the formal requirements for the implementation itself, both in terms of mandatory content, required credit points, promotion requirements and course offerings. Common to all is the emphasis on high-quality individual research work, which should be the fundamental goal of any doctoral student. Although doctoral research work is primarily focused on basic research, all foreign universities also have a strong emphasis on collaboration with industry and the orientation of research is based on the needs of high-tech companies. As for the connection with industry, our 3rd cycle study programme will be based on the latest scientific findings, while trying to transfer all new knowledge to the PhD students and thus to the industry.

Since industry is increasingly using powerful multiprocessor computers in all areas from development to production, we will place great emphasis on all numerical analyses that allow numerical simulation of various physical processes with satisfactory accuracy. Such an approach is comparable to all related foreign study programmes we have compared. The faculty has the appropriate infrastructure (software licences and also its own mini-supercomputer).

Table 1: Higher education institutions and comparable programmes

Type of the programme	Cycle	Name of the programme	Country and institution
doctoral	3rd cycle	Doctoral Programme in the Doctoral School of Mechanical Engineering (http://portal.tugraz.at/portal/page/portal/TU_Graz/Studium_Lehre/Studien/Doktoratsstudien/Maschinenbau_DS)	Austria, Doctoral School of Mechanical Engineering
doctoral	3rd cycle	Doctoral programme in Mechanical Engineering (http://www.dottorato.polimi.it/en/phd-programmes/active-phd-programmes/mechanical-engineering/)	Italy, Politecnico di Milano
doctoral	3rd cycle	PhD programme Mechanical Engineering (https://www.tue.nl/en/education/tue-graduate-school/phd-programs/)	The Netherlands, Technische Universiteit Eindhoven

The third-cycle study programme *Sustainable Technologies and Systems in Mechanical Engineering* is compared with three doctoral study programmes in European Union countries; these are: Doctoral Programme in the Doctoral School of Mechanical Engineering (Doctoral School of Mechanical Engineering, Austria), Doctoral Programme in Mechanical Engineering (Politecnico di Milano, Italy), PhD Programme in Mechanical Engineering (Technische Universiteit Eindhoven, Netherlands).

The comparison shows that the duration of all programmes is 3 years, which corresponds to 180 ECTS according to European Higher Education Area (A Framework for

Qualifications in the European Higher Education Area), although the amount of credit points of the compared programmes is not explicitly specified.

The titles that doctoral students receive upon completion of the programme are equivalent to each other.

The contents of the programmes are comparable, since in all cases they cover mechanical engineering from the perspective of construction, process, production and energy engineering sciences, thus offering the PhD students a comparable choice between the research areas.

In addition to all the above content offered in our programme, we want to emphasise research in all areas, but especially in the field of renewable energy sources, efficient energy use, numerical analysis and the use of very powerful multiprocessor computers (HPC - High Performance Computing).

Comparisons of the programme with most foreign and comparable programmes in Slovenia show that our programme has a greater emphasis on content related to the use of the most advanced approaches in the use of HPC computing infrastructure and all numerical applications in various technologies and systems that use these high performance computing capacities that they use. Differences between the programmes are also evident in the proportion of organised forms of study, but since all the doctoral programmes compared emphasise the targeted acquisition of knowledge related to the requirements of conducting research, this is precisely what brings them to a common denominator, regardless of the formalised way of fulfilling study obligations.

4 INTERNATIONAL COOPERATION OF THE INSTITUTION

On 11 December 2013, the University of Novo mesto Faculty of Mechanical Engineering received the Erasmus Charter for Higher Education – ECHE (document number: 261608-EPP-1-2014-1-SI-EPPKA3-ECHE) for the period 2014 - 2020 by the executive agency EACEA (Education, Audiovisual and Culture Executive Agency). This allows the faculty to participate in the Erasmus+ programme and enter into inter-institutional cooperation agreements with higher education institutions from other countries, which provides opportunities for international mobility of staff and students. In this way, we can enable students to complete part of their education abroad.

FTS has an active project under the Erasmus+ programme: key action 1 - Mobility of individuals in education and training, which runs from 01/06/2014 to 31/05/2016. For the implementation of the mobility, we have so far signed two inter-institutional agreements with two partner universities, namely with the University of St. Cyril and Methodius in Skopje and with the University of Trieste. We have also established contacts with other partner institutions where we can implement mobility activities for student and staff.

In line with the objective of promoting international mobility, supporting foreign language learning encouraging active participation of colleagues in professional development, we applied again in 2016 for the Erasmus+ call: key action 1 - Mobility of individuals in education and training for a 2-year period from 01/06/16 to 31/05/18. Also in the future, FTS plans to participate in such projects and strengthen its role in the international space through this mechanism.

The faculty strives to expand scientific research and development activities both domestically and internationally. In accordance with these goals, we have also built the structure of the 3rd cycle doctoral study programme, which we intend to submit for accreditation in the near future.

In this context, we envision the active involvement of the University of St. Cyril and Methodius in Skopje and the University of Trieste to implement certain courses of the proposed doctoral study programme once the programme is accredited. In the long term,

we also expect this mechanism to allow for more active participation in international research and development projects.

5 CURRICULUM AND ECTS (CREDIT POINTS) VALUES

The doctoral study of an individual candidate consists of obligations that fall into two groups:

1. **Organised forms of study (60 ECTS) – four elective courses, two seminars, presentation of the disposition of the doctoral dissertation topic and preparation and defense of the doctoral dissertation;**
2. **Research work** for a doctoral dissertation (120 ECTS). As part of the research work, the candidate must publish or have accepted for publication at least one scientific article in the field of the topic addressed in the doctoral dissertation in internationally recognised journals indexed by SCI before the defence of the doctoral dissertation. The doctoral student must be the first author of at least one article.

The following tables show the expected distribution of the doctoral student's obligations over each semester. In the first three semesters, the focus is primarily on organised forms of study, in which the student can devote himself to acquiring the necessary basic knowledge, while in the second half of the doctoral programme he/she devotes him/herself primarily to research work and to solving the scientific research problem posed.

Under the guidance of the mentor, the student usually selects four (4) courses from the doctoral studies curriculum. In principle, the student can also choose courses from other comparable programmes at other universities (up to a maximum of 20 ECTS), with due respect for the mobility rules.

5.1 Number and name of learning units

The following table shows the list of courses with the names of the learning units, the annual or total number of hours of the student's study obligations and the annual, total number of organised total or contact hours of the programme, as well as the credit evaluation of the entire programme and individual learning units according to ECTS.

Elective section of the programme

The curriculum of the proposed study programme is not divided into majors and modules, but all courses of the curriculum from different content areas are offered in one set.

6 ACCESS REQUIREMENTS AND CRITERIA FOR THE SELECTION OF CANDIDATES IN THE EVENT OF ENROLMENT RESTRICTIONS

According to Article 38a of the Higher Education Act (Official Gazette of the RS, No. 32/2012 of 4 May 2012), anyone who has completed a:

- Second cycle study programme (Bologna master's degree),
- university study programme (old programme),
- master's study programme (old programme). These candidates are recognised with study obligations in the doctoral study programme in the amount of 60 credit points.
- study programme – single master's study programme, if it is evaluated with 300 credit points.

Those who have completed equivalent education abroad also meet the enrolment requirements.

Criteria for the selection of candidates in the event of enrolment restrictions

According to Article 41 of the Act on Higher Education (Official Gazette of the RS, No. 32/2012 of 4 May 2012), the selection of candidates for admission to doctoral study programmes takes into account the success in the second cycle of studies (average grade, master's thesis grade), but it can also be the success in the optional examination determined by the study programme.

The higher education institution must obtain the consent of the Government of the Republic of Slovenia to restrict enrollment, which is announced publicly.

7 CRITERIA FOR RECOGNITION OF SKILLS AND COMPETENCES GAINED BEFORE ENROLMENT

The institute regulates the procedure for the identification, verification, validation and recognition of knowledge acquired by candidates through formal and informal education and/or casual learning, with the rules for the recognition of knowledge and skills. The procedures are managed by the Commission for Recognition of Knowledge and Skills Acquired before Enrollment, which submits a draft decision to the Dean of the faculty, and the Dean issues a final decision.

The faculty recognises knowledge and training that corresponds, in whole or in part, to the general or course-specific competences of the study programme. Recognition is given to knowledge and training acquired formally, informally and through experiential learning. The number of credit points will be approved based on the individual application and documentation submitted by the candidate.

The knowledge acquired in this manner can be recognised by the faculty based on the following:

- diploma, certificate of completed courses and other forms of continuing education,
- the assessment of products, services, publications and other copyrights of the

candidates,

- the verification and assessment of knowledge acquired by the candidate through previous self-education or experience (the possibility of fulfilling academic obligations such as examinations and interim tests without attending lectures, tutorials and seminars...),
- certain parts of the obligations (project assignments, programmes and tutorials) based on the knowledge demonstrated by copyright (projects, inventions, patents and publications),
- appropriate work experience.

Individual documented applications of candidates for the recognition of knowledge acquired prior to enrolment will be handled by the relevant committee in accordance with the procedures and rules for recognition of examinations and other academic obligations and for recognition of previously acquired knowledge. Students can request verification and assessment of knowledge if the knowledge was acquired through independent study or experience. The same criteria applies to the recognition of knowledge acquired abroad.

Article 24 of the Rules on Recognition of Knowledge and Skills states that the candidate may present public documents, certificates or other documents showing that they do not exceed a total of 20 ECTS. Otherwise, the commission must set an additional knowledge test, which will be conducted by the appointed higher educational teacher or the assessment committee.

8 ASSESSMENT METHODS

Knowledge assessment is designed to provide higher education teachers and students with ongoing, high-quality information about progress toward and achievement of established competencies/objectives of the study programme. The study programme requires students to work on the job, so knowledge assessment will also be diagnostic, formative and summative. It will take place during and after the implementation of each course.

The methods of assessment and verification of knowledge are specified in the syllabus of individual courses and are aligned with the verification of goals achieved in each course, expected academic achievements and the development of general and course-specific competences. Due to the variety of learning and teaching methods, including to ensure validity, reliability and objectivity, higher educational teachers will use different combinations of methods to assess and verify knowledge in each course. Assessment will span all taxonomic levels and will also be interested in the quality structure and organisation of knowledge.

The purpose of assessment is: to evaluate the work of students, to provide feedback on their progress and the results achieved, to enable placement in further education and employment, and to provide data for the evaluation of pedagogical work.

The methods of examination and assessment provided are: oral/written examinations, tests, fundamental, applied and developmental research assignments, oral presentations, portfolio, diaries, solving real professional problems, peer assessment, written reports, professional articles, professional papers, doctoral dissertation, master's thesis.

Student obligations are the same for all courses and include: active participation in lectures and tutorials, successfully completed project, fundamental, applied or

developmental research assignment with presentation and defence, and a successfully passed examination. The same criteria apply to advanced study programmes.

Table 2: Grading scale aligned with ECTS grading scale

Grade		Grade according to ECTS Criteria		Criteria in %	Description of knowledge
10	odlično	A	excellent	95,6–100 %	Outstanding performance with only minor errors
9	prav dobro	B	very good	84,3–95,5 %	Above-average standard but with some errors
8	prav dobro	C	good	70,8–84,2 %	Generally sound work with a number of notable errors
7	dobro	D	satisfactory	59,6–70,7 %	Fair but with significant shortcomings
6	zadostno	E	sufficient	55–59,5 %	Performance meets the minimum criteria
5 - 1	nezadostno	F	fail	0 – 54,9%	Performance does not meet the minimum criteria
*	uspešno	P	pass	55 – 100%	Performance meets the criteria
*	neuspešno	F	fail	0 – 54,9%	Performance does not meet the criteria

* Pass and fail grades are used to assess knowledge and completed obligations in the master's seminar

The student is informed orally at the beginning of each course and in writing with the syllabus about the elements of the examination and the assessment criteria.

A student must score at least 55 % to receive a passing grade. Grades on the grading scale are converted to the ECTS grading system. The procedures and rules for the verification and assessment of knowledge, as well as the procedures for the recognition of grades and credit points earned in other programmes at the same or another higher education institution, are regulated in a special set of rules

A student must score at least 55% to receive a passing grade. Grades of the ten-level numerical grading scale are converted into the ECTS grading system. The procedures and rules for the verification and assessment of knowledge, as well as the procedures for the recognition of grades and credit points earned in other programmes at the same or another higher education institution, are regulated by a special set of rules.

9 PROGRESSION REQUIREMENTS FOR THE PROGRAMME

The student can advance to the second year if he/she has fulfilled the study obligations amounting to at least 50 credit points.

The student can advance to the third year if all study obligations in the organised forms of study of the 1st and 2nd years have been fulfilled and an approved doctoral dissertation topic has been submitted.

10 PROVISIONS ON TRANSFER BETWEEN PROGRAMMES

The program does not provide for transfer between programmes of study.

11 REQUIREMENTS FOR THE COMPLETION OF THE STUDY

The requirement for completing the studies is the successful completion of all study obligations prescribed in the programme, as well as the preparation and successful defense of the doctoral dissertation. The student completes his/her studies when he/she collects all the credit points stipulated in the study programme (180 ECTS).

12 ACADEMIC TITLE

After completing the studies, students are awarded the following academic title in accordance with the Professional and Academic Titles Act:

- doktor znanosti, abbreviated dr.
- doktorica znanosti, abbreviated dr.

University of Novo mesto:
Marjan Blažič, PhD, Acad. Prof., Rector