University of Maribor

FRAMEWORK PROGRAMME OF EARLY STAGE RESEARCHER TRAINING[1]

1. BASIC DATA

Mentor's name and surname	**Gorazd Štumberger**	Mentor's register number at ARIS (SICRIS):	**10814**
Mentor's e-mail:	gorazd.stumberger@um.si	Mentor's tel. no.:	+386 (0)2 220 7075
Research programme (RP) leader's name and surname:	Gorazd Štumberger	RP leader's register number at ARIS (SICRIS):	10814
Title of research programme:	Control of electromechanical systems	RP's Register number at ARIS (SICRIS):	P2-0115
Research organisation (RO) of University of Maribor, where training shall be conducted:	Faculty of Electrical Engineering and Computer Science	RO Register number at ARIS (SICRIS):	0552-0796
Research field according to ARIS classification:	2.12	Research field according to EURAXESS classification	Electrical engineering

2. DEFINITION OF RESEARCH PROBLEM AND GOALS OF DOCTORAL RESEARCH[2]

Starting point of research task of the early stage researcher and its position in the research programme, where the mentor is included, work hypothesis, research goals and foreseen result with emphasis on an original contribution to science:

The research project will address the field of high-frequency disturbances in electrical networks, known as supraharmonics. These occur primarily due to the operation of power-electronic converters, such as photovoltaic inverters, battery energy storage systems, and electric vehicle chargers that lack appropriate output filters. Since such converters inject current and voltage components into the grid at frequencies above classical harmonics, they can cause unwanted interactions with various electrical devices. As a result, overheating, additional losses, operational disturbances, and reduced lifespan may occur in both household and industrial consumers as well as in distribution network elements (cables, transformers, fuses, switches,

[1] *Term early stage researcher (ESR) is written in male form and used as neutral for women and men.*

[2] *Research and study programme of training have to harmonise with contents of the research programme, where the mentor is a member.*

etc.). This represents a significant technical and economic risk, as it reduces the reliability of the power system and increases maintenance costs and losses.

The research will take place within the research program Control of electromechanical systems P2-0115, under the Institute of power engineering at UM FERI. The program group systematically focuses on advanced approaches to the design, control, and optimization of electromechanical and power-electronic systems, which is why the topic of supraharmonics fits directly and strategically into the existing research priorities and further enhances them.

The research will be divided into three interconnected but content-wise independent segments, enabling a gradual deepening of knowledge and adaptation of methods depending on ongoing results:
(A) Experimental investigation of supraharmonics in a real low-voltage network. This includes field measurements at different points in the network, featuring diverse sources of supraharmonics and various types of consumers. The goal is to capture a wide range of operating states, configurations, and conditions.
(B) Investigation of supraharmonics in a controlled laboratory environment. The laboratory enables precise reconstruction of selected phenomena, isolation of individual influences, and testing of different measurement and filtering techniques for supraharmonics.
(C) Analysis of supraharmonics and development of theoretical tools for their treatment. This part emphasizes mathematical tools, modeling, analysis of interactions between supraharmonic sources and consumers, and the development of mathematical methods.

The working hypotheses of the research are:
(H1) Supraharmonics cause interactions with most devices connected to the low-voltage network. This interaction appears as high-frequency currents in the supraharmonic range between the source and consumers.
(H2) Increased exposure to supraharmonic components leads to accelerated degradation of network elements and electrical devices, resulting in a shortened lifespan and higher failure rates.

The goals of the research are to develop a comprehensive experimental and analytical approach to identifying and characterizing supraharmonics, determine dominant supraharmonic sources in real networks, quantify the impact of supraharmonics on the performance and wear of different types of electrical consumers and network components, create models and criteria that enable risk assessment and propose mitigation measures, and contribute to the development of standardized measurement methods for supraharmonics.

The expected research outcomes include the establishment of extensive databases of supraharmonic measurements under real network conditions, the development of advanced laboratory protocols for their systematic investigation, and new measurement-based analytical tools for studying interactions between supraharmonic sources and consumers. The original contribution of the research will lie in the comprehensive evaluation of supraharmonic impacts on various elements of the power system, with a methodology combining field measurements, laboratory experiments, and theoretical analysis. This will enable a deeper understanding of the mechanisms affecting the lifespan of electrical equipment.

The results will be directly applicable in designing protective measures, upgrading power quality standards, and optimizing the operation of networks with high penetration of power-electronic devices.

3. STUDY PROGRAMME

Foreseen study programme, to which early stage researcher shall be enrolled in academic year 2026/2027:

The training of the young researcher will be organized and scheduled in accordance with the study program Electrical Engineering of the Doctoral school of the Faculty of electrical engineering, computer science and informatics at the University of Maribor. A detailed program is available at: https://feri.um.si/studij/programi/tretja-stopnja/dr/e/

The program is designed as a three-year study with the possibility of an additional “absolvent” year, and the study and research work will proceed year by year as follows:
In the first year, the student will complete the requirements of the 1st-year curriculum, including compulsory and elective exams as well as seminar assignments. At the same time, they will become familiar with and integrated into the ongoing research activities of the research group and its projects. They will conduct preliminary research on the selected topic, define the research area and challenges, study the relevant scientific literature, and prepare and write initial scientific-research (review) papers. The student will also participate in international projects related to the research topic.

In the second year, the student will complete the requirements of the 2nd-year curriculum, which includes elective exams, seminar assignments, and individual research work. They will define the research problem in detail and focus on intensive research activities. They will prepare and write original scientific papers for presentation at conferences and publication in journals with an impact factor, continue participating in international projects related to the research field, present research results internally at the institute as well as at local and international events or conferences, and establish domestic and international professional connections.

In the third year, the student will complete all remaining study obligations, undertake at least a one-month research exchange at a foreign research institution, and prepare the dissertation proposal.

The fourth year will be dedicated to testing the scientific hypotheses, verifying the dissertation’s suitability, preparing and submitting the doctoral dissertation, strengthening and seeking new international collaborations, and defending the dissertation.

4. DESCRIPTION OF WORK AND TASKS

The tasks arise from the description of the work program in Section 3.

5. REQUESTED LEVEL OF EDUCATION

17003 – Master's degree (second Bologna cycle)

6. REQUESTED FIELD OF EDUCATION

Electrical power engineering

7. KLASIUS SRV

17003 - Master's degree (second Bologna cycle)

8. KLASIUS P

0713 - Electricity and energy

9. REQUESTED KNOWLEDGE

Knowledge in the field of electrical power engineering.

10. REQUESTED SPECIAL REQUIREMENTS

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11. REQUESTED LANGUAGES

Slovene
English

12. REQUESTED WORK EXPERIENCE

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13. FORESEEN POSTDOCTORAL TRAINING

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Mentor's signature:

Gorazd Štumberger Digitally signed by Gorazd Štumberger
Date: 2026.02.10 19:25:18 +01'00'

Research programme leader's signature:

Gorazd Štumberger Digitally signed by Gorazd Štumberger
Date: 2026.02.10 19:25:43 +01'00'

Name and surname of Dean or authorised person[3]:

Prof. dr. Gorazd Štumberger

Signature of dean or authorised person:

Digitally signed by Marko Hölbl
Date: 2026.02.10 19:34:38 +01'00'

Place and date:

Kliknite ali tapnite tukaj, če želite vnesti besedilo. Kliknite ali tapnite tukaj, če želite vnesti datum.

Stamp:

[3] The training program is signed by the dean of the member where the ESR's employment and training will take place.

Univerza v Mariboru

Fakulteta za elektrotehniko,
računalništvo in informatiko
Koroška cesta 46
2000 Maribor, Slovenija

Datum: 26. 1. 2026

Na podlagi 24. člena Zakona o visokem šolstvu (ZViS-UPB7, Ur. list RS, št. 32/12, 75/16) in 330. člena Statuta UM (Statut UM - UPB 12, Ur. list RS št. 29/2017, s sprem. do 32/19) dekan Fakultete za elektrotehniko, računalništvo in informatiko prof. dr. Gorazd Štumberger izdajam naslednje

POOBLASTILO

Pooblaščam prodekana izr. prof. dr. Marka Hölbla, da me v času moje odsotnosti dne 9. 2. do 12. 2. 2026 nadomešča in odloča o zadevah ter podpisuje vse dokumente, ki so potrebni za tekoče poslovanje fakultete.

Pooblastilo velja do preklica.

UNIVERZA V MARIBORU FAKULTETA ZA ELEKTROTEHNIKO RAČUNALNIŠTVO IN INFORMATIKO 1

D E K A N
prof. dr. Gorazd Štumberger